HRS DOCUMENTATION RECORD--COVER SHEET

Name of Site: Hockessin Groundwater

EPA ID No.: DEN000303920

Date Prepared: January 2018

Contact Person: Lorie Baker
U.S. Environmental Protection Agency
Philadelphia, Pennsylvania
(215) 814-3355
Baker.Lorie@epa.gov

Pathways, Components, or Threats Not Scored

Surface Water Migration Pathway, Soil Exposure and Subsurface Intrusion Pathway, and Air Migration Pathway:

The Surface Water Migration Pathway, Soil Exposure and Subsurface Intrusion Pathway, and Air Migration Pathway were not scored as part of this Hazard Ranking System (HRS) evaluation. These pathways were not included because a documented release to these media would not significantly affect the overall score and because the ground water migration pathway produces an overall score above the minimum requirement for the Hockessin Groundwater site to qualify for inclusion on the National Priorities List (NPL).

This page has been left blank intentionally.

HRS DOCUMENTATION RECORD

Name of Site: Hockessin Groundwater Date Prepared: January 2018

EPA ID No.: DEN000303920

EPA Region: 3

Street Address of Site*: Old Lancaster Pike at railroad crossing

County and State: Hockessin, New Castle County, Delaware 19707

General Location in the State: Northern Delaware

Topographic Map: Kennett Square, PA/DE

Latitude*: 39° 47' 15.072" (39.78752°) Longitude*: -75° 41' 47.4462" (-75.696513)

The reference point for the street address and site latitude/longitude coordinates corresponds to the location of observation well OB10 in Hockessin, Delaware, as shown on **Figures 1 and 2** of this Hazard Ranking System (HRS) documentation record [Refs. 3; 4; 55, p. 2; 56].

* The street address, coordinates, and contaminant locations presented in this HRS documentation record identify the general area the site is located. They represent one or more locations EPA considers to be part of the site based on the screening information EPA used to evaluate the site for NPL listing. EPA lists national priorities among the known "releases or threatened releases" of hazardous substances; thus, the focus is on the release, not precisely delineated boundaries. A site is defined as where a hazardous substance has been "deposited, stored, disposed, or placed, or has otherwise come to be located." Generally, HRS scoring and the subsequent listing of a release merely represent the initial determination that a certain area may need to be addressed under CERCLA. Accordingly, EPA contemplates that the preliminary description of facility boundaries at the time of scoring will be refined as more information is developed as to where the contamination has come to be located.

Scores

Ground Water[1] Pathway	100.00
Surface Water Pathway	Not Scored
Soil Exposure and Subsurface Intrusion Pathway	Not Scored
Air Pathway	Not Scored

HRS SITE SCORE 50.00

[1] "Ground water" and "groundwater" are synonymous; the spelling is different due to "ground water" being codified as part of the HRS, while "groundwater" is the modern spelling.

WORKSHEET FOR COMPUTING HRS SITE SCORE
Hockessin Groundwater

		S	S^2
1.	Ground Water Migration Pathway Score (S_{gw}) (from Table 3-1, line 13)	100.00	10,000
2a.	Surface Water Overland/Flood Migration Component (from Table 4-1, line 30)	Not Scored	
2b.	Ground Water to Surface Water Migration Component (from Table 4-25, line 28)	Not Scored	
2c.	Surface Water Migration Pathway Score (S_{sw}) Enter the larger of lines 2a and 2b as the pathway score.	Not Scored	
3.	Soil Exposure and Subsurface Intrusion Pathway Score (S_{sessi}) (from Table 5-1, line 22)	Not Scored	
4.	Air Migration Pathway Score (S_a) (from Table 6-1, line 12)	Not Scored	
5.	Total of $S_{gw}^2 + S_{sw}^2 + S_{sessi}^2 + S_a^2$	10,000	
6.	**HRS Site Score** Divide the value on line 5 by 4 and take the square root	50.00	

GROUND WATER MIGRATION PATHWAY SCORESHEET
Hockessin Groundwater

GROUND WATER MIGRATION PATHWAY Factor Categories & Factors	**MAXIMUM VALUE**	**VALUE ASSIGNED**
Likelihood of Release		
1. Observed Release	550	550
2. Potential to Release		
2a. Containment	10	Not scored
2b. Net Precipitation	10	Not scored
2c. Depth to Aquifer	5	Not scored
2d. Travel Time	35	Not scored
2e. Potential to Release [lines 2a(2b+2c+2d)]	500	Not scored
3. Likelihood of Release	550	550
Waste Characteristics		
4. Toxicity/Mobility	*	1,000
5. Hazardous Waste Quantity	*	100
6. Waste Characteristics	100	18
Targets		
7. Nearest Well	50	50
8. Population		
8a. Level I Concentrations	**	104,385.6
8b. Level II Concentrations	**	6,959.04
8c. Potential Contamination	**	Not scored
8d. Population (lines 8a+8b+8c)	**	111,344.64
9. Resources	5	Not scored
10. Wellhead Protection Area	20	20
11. Targets (lines 7+8d+9+10)	**	111,414.64
12. Aquifer Score (lines 3x6x11 divided by 82,500)	100	100.00
13. Ground Water Migration Pathway Score (S_{gw})	100	100.00

* Maximum value applies to waste characteristics category.
** Maximum value not applicable.

REFERENCES

Reference Number	Description of the Reference
1.	U.S. Environmental Protection Agency (EPA). Hazard Ranking System, Final Rule. Federal Register, Volume 55, No. 241, pp. 51532–51667. December 14, 1990. Available at http://semspub.epa.gov/src/document/HQ/174028. [136 pages]
1a.	EPA. Addition of a Subsurface Intrusion Component to the Hazard Ranking System, 40 Code of Federal Regulations Part 300, 82 Federal Register 2760. January 9, 2017. Available on-line at https://www.regulations.gov/document?D=EPA-HQ-SFUND-2010-1086-0104. [48 pages]
2.	EPA. Superfund Chemical Data Matrix (SCDM) Query, Substances: Dichloroethylene, 1,2-cis-, Tetrachloroethylene, and Trichloroethylene; Factor Values and Benchmarks: Ground Water Pathway. Query accessed October 6, 2017. A complete copy of SCDM is available at http://www.epa.gov/superfund/superfund-chemical-data-matrix-scdm. [13 pages]
3.	EPA. Superfund Site Information, Hockessin Groundwater (EPA ID: DEN000303920): Site Information. Available at https://cumulis.epa.gov/supercpad/cursites/csitinfo.cfm?id=0303920&msspp. Updated as of December 7, 2017. [1 page]
4.	U.S. Geological Survey (USGS). Kennett Square, Pennsylvania/Delaware Quadrangle (7.5×7.5-minute series topographic map). 1973, revised 1974. [1 map]
5.	Delaware Department of Natural Resources and Environmental Control (DNREC). Correspondence from Phillip G. Retallick, Director, Division of Air and Waste Management to Mr. Keith Wein, Owner, Sunrise Cleaners Regarding Notice of Violation. August 1989. [3 pages]
6.	Goldberg, Zoino, and Associates, Inc. Correspondence from Bruce Nickelson, Project Manager, to General Electric Capital Corporation Regarding Preliminary Environmental Assessment of the Shoppes of Hockessin. February 23, 1989. [11 pages]
7.	DNREC. The Impact of Known and Suspected Contaminant Sources on Select Public Drinking Water Supplies in Delaware. September 2002. [91 pages]
8.	EAWAG-BBD. Tetrachloroethene Pathway Map (Anaerobic). Accessed January 31, 2017. Available at http://eawag-bbd.ethz.ch/tce2/tce2_map.html. [3 pages]
9.	DNREC, Site Restoration and Investigation Branch. Preliminary Assessment of the Hockessin Groundwater Site, DE-1317. July 2005. [25 pages]
10.	Duffield Associates, Inc. Evaluation of Soil and Sediment – Sunrise Cleaners Site Project No. 9620.EE. October 2013. [118 pages]
11.	Duffield Associates, Inc. Letter to Mr. Robert C. Asreen, Hydrologist, Department of Natural Resources and Environmental Control, Site Investigation and Restoration Section, Re: Workplan for Soil and Sediment, Sunrise Cleaners 7288 Lancaster Pike. January 25, 2013. [207 pages]
12.	DNREC. Voluntary Cleanup Program Agreement, with Shoppes of Hockessin (i.e. Respondent) in the matter of Sunrise Cleaners Site (DE-1532). June 10, 2013. [9 pages]

REFERENCES (continued)

Reference Number	Description of the Reference
13.	Duffield Associates, Inc. Preliminary Evaluation of Groundwater – Sunrise Cleaners Site (DE-1532). July, 2015. [2,986 pages]
14.	Black & Veatch. Facility Evaluation Report – Hockessin Cleaners Site (DE-1591). June 24, 2015. [766 pages]
15.	Black & Veatch. Facility Evaluation Report – Thompson Cleaners Site (DE-1590). August 20, 2015. [396 pages]
16.	Duffield Associates, Inc. Groundwater Monitoring Report, Second Quarter, Sunrise Cleaners (DE-1532). September 2016. [206 pages]
17.	Duffield Associates, Inc. Letter to Mr. Robert C. Asreen, Hydrologist, Department of Natural Resources and Environmental Control, Site Investigation and Restoration Section. Re: Report of Vapor Assessment – Eastern and Western Floor Slab, Sunrise Cleaners – 7288 Lancaster Pike. October 16, 2015. [527 pages]
18.	Duffield Associates, Inc. Letter to Mr. Robert C. Asreen, Hydrologist, Department of Natural Resources and Environmental Control, Site Investigation and Restoration Section. Re: Soil Vapor Extraction Report – Initial Three Months, Sunrise Cleaners – 7288 Lancaster Pike. September 28, 2016. [26 pages]
19.	DNREC. Voluntary Cleanup Program Agreement, with Hartnett Properties (i.e. Respondent) in the matter of Hockessin Cleaners Site (DE-1591). April 8, 2016. [9 pages]
20.	Ten Bears Environmental. Letter to Mr. Robert C. Asreen, Hydrologist, Department of Natural Resources and Environmental Control, Site Investigation and Restoration Section. Re: Results of Soil and Groundwater Sampling, Phase II Facility Evaluation – Hockessin Cleaners Site (DE-1591). September 29, 2016. [108 pages]
21.	Agency for Toxic Substances & Disease Registry (ATSDR). Division of Toxicology ToxFAQs™, Tetrachloroethylene (PCE) CAS# 127-18-4. October 2014. [2 pages]
22.	Environmental Data Resources, Inc. (EDR). The EDR Radium Map™ Report – Hockessin Groundwater Site. Inquiry Number: 4836759.2s. January 25, 2017. [107 pages]
23.	Shannon, Nancy, Weston Solutions, Inc. (WESTON). Electronic Mail Correspondence with Virginia Eisenbrey, Artesian Water Company Re: Distribution System. March 24-April 28, 2017. [3 pages]
24.	United States Census Bureau. Quick Facts New Castle County, Delaware. Information Accessed On-line, https://www.census.gov/quickfacts/table/PST045216/10003,00. April 27, 2017. [3 pages]
25.	Shannon, Nancy, WESTON. Project Note to Hockessin Groundwater Site File. Subject: Electronic Mail Correspondence with Steven Repole, Finance Director, Town of Elkton Re: Water Distribution System - Artesian. September 11, 2017. [3 pages]
26.	Artesian Water Company. Correspondence from C. Thomas deLorimier, P.E., Manager of Engineering to John Brandt, P.G., DNREC, Water Supply Section, Section Manager, Re: Self-Sufficiency Act 2003. June 25, 2015. [73 pages]

REFERENCES (continued)

Reference Number	Description of the Reference
27.	Weston Solutions, Inc. (WESTON). Final Trip Report – Hockessin Groundwater Site. December 1, 2016. [172 pages]
28.	WESTON. Chain of Custody Record – Case 46484. September 22, 2016. [5 pages]
29.	McDonald, Brandon, EPA, Region III ESAT PO. Memorandum with attachment to Rich Rupert, EPA, On-Scene Coordinator. Subject: Region III Data QA Review – Organic Data Validation Report for the Hockessin Groundwater Site – Case # 46484 (SDG # C0AA0). November 8, 2016. [864 pages]
30.	McDonald, Brandon, EPA, Region III ESAT PO. Memorandum with attachment to Rich Rupert, EPA, On-Scene Coordinator. Subject: Region III Data QA Review – Organic Data Validation Report for the Hockessin Groundwater Site – Case # 46484(SDG # C0AA5). November 8, 2016. [543 pages]
31.	McDonald, Brandon, EPA, Region III ESAT PO. Memorandum with attachment to Rich Rupert, EPA, On-Scene Coordinator. Subject: Region III Data QA Review – Organic Data Validation Report for the Hockessin Groundwater Site – Case # 46423 (SDG # C0AC1). November 2, 2016. [450 pages]
32.	Williams, Paul. Ground-Water Availability, Hockessin, Delaware. January-February 1981. [9 pages]
33.	Delaware Geological Survey (DGS). Geology and Hydrology of the Cockeysville Formation Northern New Castle County, Delaware. Bulletin No. 19. Newark, Delaware. 1995. [65 pages]
34.	DGS. Bedrock Geology of the Piedmont of Delaware and Adjacent Pennsylvania. Report of Investigation No. 59. Newark, Delaware. 2000. [57 pages]
35.	DGS. Sinkholes, Hockessin Area, Delaware. Open File Report No. 14. Newark, Delaware. March 1981. [17 pages]
36.	Shannon, Nancy, WESTON. Project Note to Hockessin Groundwater Site File. Subject: Artesian Water Company Well Logs (with attachments). May 11, 2017. [8 pages]
37.	Shannon, Nancy, WESTON. Project Note to Hockessin Groundwater Site File. Subject: Electronic Data Deliverable (excerpt). May 10, 2017. [4 pages]
38.	EPA Contract Laboratory Program. Statement of Work for Organic Superfund Methods, Multi-Media, Multi-Concentration, SOM02.3. September 2015. [512 pages]
39.	Shannon, Nancy, WESTON. Project Note to Hockessin Groundwater Site File. Subject: Delaware Geological Survey Wells near Hockessin. May 17, 2017. [3 pages]
40.	EPA. Using Qualified Data to Document an Observed Release and Observed Contamination. November 1996. [18 pages]
41.	TestAmerica. Analytical Report, Job Number 460-58505-1, Sunrise Cleaners. Prepared for Duffield Associates, Wilmington, Delaware. July 22, 2013. [1386 pages]
42.	TestAmerica. Analytical Report, Job Number 460-58506-1, Sunrise Cleaners. Prepared for Duffield Associates, Wilmington, Delaware. July 19, 2013. [233 pages]
43.	TestAmerica. Analytical Report, Job Number 460-58507-1, Sunrise Cleaners. Prepared for Duffield Associates, Wilmington, Delaware. July 17, 2013. [230 pages]

REFERENCES (continued)

Reference Number	Description of the Reference
44.	TestAmerica. Analytical Report, Job Number 460-58577-1, Sunrise Cleaners. Prepared for Duffield Associates, Wilmington, Delaware. July 19, 2013. [302 pages]
45.	Shannon, Nancy, WESTON. Project Note to Hockessin Groundwater Site File. Subject: Clarification of Number of Groundwater Wells used by Artesian. June 2, 2017. [1 page]
46.	DGS. Delaware Geologic Information Resource, Wellhead Protection Areas. Information Accessed On-line, http://maps.dgs.udel.edu/dgir/draft/. November 22, 2017. [2 pages]
47.	McDonald, Brandon, EPA, Region III ESAT PO. Memorandum with attachment to Rich Rupert, EPA, On-Scene Coordinator. Subject: Region III Data QA Review – Organic Data Validation Report for the Hockessin Groundwater Site – Case # 46925 (SDG # C0AL9). May 25, 2017. [851 pages]
48.	McDonald, Brandon, EPA, Region III ESAT PO. Memorandum with attachment to Rich Rupert, EPA, On-Scene Coordinator. Subject: Region III Data QA Review – Organic Data Validation Report for the Hockessin Groundwater Site – Case # 46925 (SDG # C0AN1). May 25, 2017. [526 pages]
49.	McDonald, Brandon, EPA, Region III ESAT PO. Memorandum with attachment to Rich Rupert, EPA, On-Scene Coordinator. Subject: Region III Data QA Review – Organic Data Validation Report for the Hockessin Groundwater Site – Case # 46925 (SDG # C0AN9). May 25, 2017. [675 pages]
50.	Shannon, Nancy, WESTON. Project Note to Hockessin Groundwater Site File. Subject: Electronic Data Deliverable (excerpt). August 10, 2017. [4 pages]
51.	Shannon, Nancy, WESTON. Project Note to Hockessin Groundwater Site File. Subject: April 2017 Field Notes (excerpt). August 28, 2017. [28 pages]
52.	Artesian Water Company. Water Quality Report for 2016. PWSID# DE0000552. Spring 2017. [6 pages]
53.	McDonald, Brandon, EPA, Region III ESAT PO. Memorandum with attachment to Rich Rupert, EPA, On-Scene Coordinator. Subject: Region III Data QA Review – Organic Data Validation Report for the Hockessin Groundwater Site – Case # 47015 (SDG # C0AT6). July 6, 2017. [14 pages]
54.	Shannon, Nancy, WESTON. Project Note to Hockessin Groundwater Site File. Subject: Delaware Geological Survey Well Information for 42195. August 28, 2017. [6 pages]
55.	Shannon, Nancy, WESTON. Project Note to Hockessin Groundwater Site File. Subject: Figures Depicting Site Layout and Groundwater Samples Location. September 11, 2017. [6 pages]
56.	Shannon, Nancy, WESTON. Project Note to Hockessin Groundwater Site File. Subject: Public Supply Wells and Observation Wells Locations. September 22, 2017. [2 pages]
57.	DNREC. State of Delaware Wellhead Protection Program. Information Accessed On-line, http://www.dnrec.state.de.us/water2000/Sections/WatSupp/Library/WH.pdf. October 6, 2017. [40 pages].

SITE SUMMARY

The Hockessin Groundwater site is located in Hockessin, New Castle County, Delaware [Refs. 3 and 4]. The geographic coordinates of the site are 39.78752˚ latitude and -75.696513˚ longitude, based on the location of observation well OB10 at the intersection of Old Lancaster Pike and the railroad crossing in Hockessin, Delaware [**Figures 1 and 2**; Refs. 3; 4; 55 p. 2; 56]. The site as scored for HRS purposes consists of two contaminated soil sources and a commingled contaminated groundwater plume. The sources are located at Sunrise Cleaners and Hockessin Cleaners (**Figures 2, 3, and 4**), which have documented surface and subsurface soil containing volatile organic compounds (VOCs), primarily tetrachloroethylene (PCE), trichloroethylene (TCE) and cis-1,2-dichloroethylene (cis-1,2-DCE), based on data collected by the potentially responsible parties (PRPs) under the State of Delaware's Voluntary Cleanup Program (VCP) (see **Section 2.2** of this HRS documentation record). As part of this HRS Documentation Record, a release of VOCs from the sources at each of the dry cleaning facilities to the ground water migration pathway is documented by groundwater samples collected from monitoring wells located at both dry cleaning facilities, public supply wells, and observation wells that meet the criteria for an observed release. Three public wells are subject to Level I contamination of VOCs and two public wells are subject to Level II contamination of VOCs, as further discussed in **Sections 3.1.1 and 3.3** of this HRS documentation record. The commingled groundwater plume is depicted on **Figure 5** based on groundwater sample locations with detections of PCE, TCE, and cis-1,2-DCE that meet the criteria for an observed release (**Section 3.1.1** of this HRS documentation record and Reference 55). Analytical results for samples collected from domestic and irrigation wells also show the presence of site-related contaminants in groundwater [Ref. 27, pp. 45 and 46; 28, pp. 2 and 3; 30, pp. 9-14, 124, 151, and 162; 31, pp. 5, 6, and 73; 47, pp. 5, 8, 14, 20, 84, 120, and 169; 51, pp. 2, and 5-9; 53, p. 4]; however, an observed release was not evaluated for the domestic and irrigation wells as part of this HRS documentation record. The two sources from the two facilities (Sunrise Cleaners and Hockessin Cleaners) are contributing to the commingled contamination in the aquifer; and the releases have been grouped to reflect that the contamination has commingled, impacts the same target wells and the Region wishes to manage the remediation as a single action. Source-specific scoresheets were also generated in the evaluation of this site. These source-specific scoresheets in Appendices A and B of this HRS documentation record show that even if the releases from the two sources were evaluated independently, they both score above 28.50 and qualify for the NPL.

In August 1988, the Delaware Department of Natural Resources and Environmental Control (DNREC) conducted an inspection of a dry-cleaning facility (Sunrise Cleaners) located in a commercial shopping center (Shoppes of Hockessin) at 7288 Lancaster Pike in Hockessin, Delaware [Ref. 5, p. 1]. DNREC issued a Notice of Violation to Sunrise Cleaners in November 1988 for the disposal of hazardous waste in an unlawful manner, namely disposal of material into a dumpster [Ref. 5, p. 1]. In 1989, the property owner of the shopping center in which Sunrise Cleaners is located conducted a preliminary environmental assessment [Ref. 6, p. 1]. As part of the assessment, the owner of Sunrise Cleaners was interviewed and stated that approximately 200 gallons of PCE per year is used as a cleaning solvent [Ref. 6, p. 3]. The owner also indicated that no PCE waste is generated, either as non-useable fluid or machine still bottoms, and that all reported PCE loss is as a result of evaporation [Ref. 6, p. 3]. Diatomaceous earth filters were used in the dry-cleaning process [Ref. 6, p. 3]. The spent filters were reportedly drained for 3 days into the machines, then discarded into a dumpster located outside of the building awaiting off-site disposal [Ref. 6, pp. 3 and 9].

In 2002, DNREC conducted a Drinking Water Impact Study of public water systems throughout the State of Delaware [Ref. 7, p. 1]. As part of the study, groundwater samples were collected from three public supply wells owned and operated by Artesian Water Company (PG1, PG3, and P4) and located in Hockessin, Delaware [Ref. 7, pp. 14 and 26]. Analytical results indicated the presence of PCE in all three wells ranging from 3.1 to 5.7 micrograms per liter (µg/L), as well as in the post-treatment sample at a concentration of 2.1 µg/L [Ref. 7, pp. 26 and 28]. PCE breakdown products such as trichloroethylene (TCE), 1,1-dichloroethylene (1,1-DCE), and cis-1,2-DCE were also detected in the public supply wells [Refs. 7, p. 28; 8, pp. 2 and 3]. In 2005, DNREC conducted a CERCLA Preliminary Assessment (PA) to investigate the possible sources of the PCE identified in the public supply wells in Hockessin, Delaware [Ref. 9 pp. 1, 2, 5]. The PA identified four dry-cleaning facilities, three operating gas stations, one former gas station, and one automobile service center as possible sources located within a 32-acre area bound by Route 41 (Lancaster Pike) to the north, the Shoppes of Hockessin shopping center to the east, Old Lancaster Pike to the south, and Valley Road to the west [Ref. 9, pp. 2, 5-11, and 16].

In August 2012, soil samples were collected from the Shoppes of Hockessin by the property owner as part of a due diligence for refinancing [Ref. 10, p. 4]. Analytical results indicated the presence of PCE up to 30,000,000 micrograms per kilogram (µg/kg), with the highest concentration in a soil sample collected at 19.5 feet below ground surface (bgs) adjacent to a dry-cleaning facility, Sunrise Cleaners [Ref. 11, pp. 11 and 13]. In May 2013, the property owners for the Shoppes of Hockessin entered into DNREC's Voluntary Cleanup Program (VCP) [Ref. 12, pp. 1-9]. In June 2013, an investigation was conducted of the soil in the vicinity of Sunrise Cleaners by the shopping center property owner [Ref. 10, pp. 1, 8, 9, 11, and 20]. Collected soil samples showed the presence of PCE at concentrations as high as 11,000 µg/kg at a depth of 19 to 19.5 feet bgs and as deep as 32 to 32.5 feet bgs at a concentration of 7,900 µg/kg [Ref. 10, p. 34]. Additionally, PCE breakdown products such as TCE (as high as 300 µg/kg) and cis-1,2-DCE (as high as 1,300 µg/kg) were detected in the soil samples ranging in depth from 2 to 32.5 feet bgs [Refs. 8, pp. 2 and 3; 10, p. 34]. In 2015, under the VCP, the property owner of the Shoppes of Hockessin installed six monitoring wells ranging in depth from 10 to 52 feet bgs in the vicinity of Sunrise Cleaners [Ref. 13, pp. 18 and 22]. Analytical results for groundwater samples collected from the monitoring wells indicated the presence of PCE as high as 13,000 µg/L [Ref. 13, p. 24].

In 2015, DNREC conducted facility investigations at two additional dry-cleaning facilities, Hockessin Cleaners and Thompson Cleaners, in Hockessin, Delaware, in an attempt to further determine the source of PCE in the public supply wells [Refs. 14, pp. 1 and 7; 15, pp. 1 and 5]. An investigation was not conducted at the fourth dry-cleaning facility, Reynolds Dry Cleaning, identified in the 2005 CERCLA PA, because it was determined that this facility was a drop-off location only; no dry-cleaning activities take place on the premises [Ref. 9, p. 6]. At Hockessin Cleaners, located at 7313 Lancaster Pike, DNREC collected 10 surface soil samples and advanced four soil borings for subsurface soil sample collection [Ref. 14, pp. 9, 21, 22, and 37]. Analytical results for the collected soil samples indicated the presence of PCE as high as 1,100 µg/kg in a surface soil sample and 3,000 µg/kg at a depth of 22 to 24 feet bgs [Ref. 14, pp. 26-30]. Additionally, PCE breakdown products such as TCE (as high as 130 µg/kg-estimated) and cis-1,2-DCE (as high as 520 µg/kg) were detected in the soil samples [Refs. 8, pp. 2 and 3; 14, pp. 26-30]. Analytical results for surface and subsurface soil samples collected from Thompson Cleaners, located at 7465 Lancaster Pike, did not show the presence of PCE or its breakdown products [Refs. 9, p. 6; 15, p. 19].

Throughout 2016, under the VCP, the property owner at Sunrise Cleaners conducted environmental investigations, including quarterly monitoring well sampling and soil gas sampling [Refs. 16, pp. 3 and 10; 17, pp. 1-3, and 6]. In April 2016, a soil vapor extraction/air sparging remediation system was installed and began operating at Sunrise Cleaners [Ref. 18, pp. 1, 3, and 6].

In April 2016, Hartnett Properties, the owners of the property on which Hockessin Cleaners is located, entered into DNREC's VCP [Ref. 19, pp. 1-9]. In August 2016, Hartnett Properties conducted a Phase II facility investigation in the vicinity of Hockessin Cleaners, which included the collection of soil and groundwater samples [Ref. 20, pp. 1 and 2]. Analytical results for soil samples documented the presence of PCE as high as 5,900 µg/kg [Ref. 20, pp. 2 and 7]. Additionally, PCE breakdown products, such as TCE (as high as 610 µg/kg) and cis-1,2-DCE (as high as 510 µg/kg), were detected in the soil samples ranging in depth from 0 to 21 feet bgs [Refs. 8, pp. 2 and 3; 20, p. 7]. Groundwater samples contained PCE at concentrations as high as 7,500 µg/L [Ref. 20, p. 8]. Groundwater samples also contained PCE breakdown products such as TCE (as high as 1,100 µg/L), cis-1,2-DCE (as high as 1,000 µg/L), and vinyl chloride (as high as 6 µg/L) [Refs. 8, pp. 2 and 3; 20, p. 8].

In September 2016, as part of an EPA Removal Action, groundwater samples were collected from the six Hockessin public supply wells and two observation wells owned by Artesian [Refs. 27, pp. 2-3, 30-33, 35-41, and 46; 28, p. 1]. As further presented in **Section 3.1.1** of this HRS documentation record, analytical results for the samples showed the presence of PCE in three of the six public supply wells and in one of the observation wells; PCE ranged in concentration from 16 µg/L to 390 µg/L [Refs. 29, pp.12-15, 38-41, 133, 145, 157, 199, 211, 222, and 234; 30, pp. 5-8, 78, 90, 101, and 113]. Additionally, the samples contained PCE breakdown products such as TCE (as high as 1.1 µg/L) and cis-1,2-DCE (as high as 0.68 µg/L) [Refs. 8, pp. 2 and 3; 29, pp.12-15, 38-41, 132, 144, 198, 221, and 233; 30, pp. 5-8, 77, and 100].

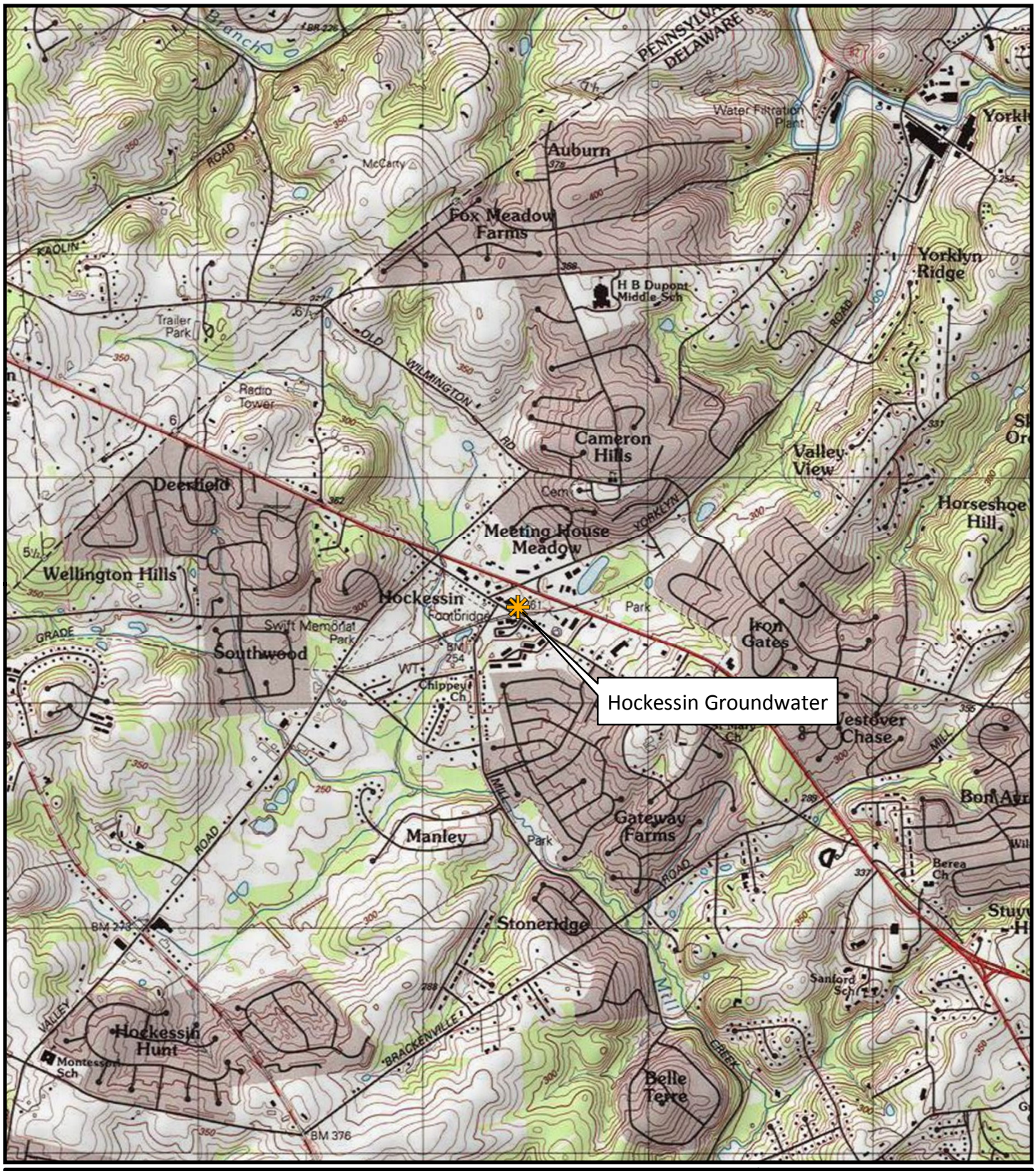
In April 2017, as part of an EPA Removal Action, a second round of groundwater samples were collected from the six Hockessin public supply wells and the two observation wells owned by Artesian [Ref. 51, pp. 3, 4, and 19-27]. Groundwater samples were also collected from five of the six monitoring wells located at Sunrise Cleaners, from the three monitoring wells located at Hockessin Cleaners, and from an observation well owned by the Delaware

Geological Survey (DGS) [Ref. 51, pp. 3, 4, and 10-18]. As further presented in **Section 3.1.1** of this HRS documentation record, analytical results for the samples showed the presence of PCE in five of the six public supply wells and in one of the observation wells ranging from 0.58 µg/L to 250 µg/L [Refs. 47, pp. 21, 24, 26, 214, 237, and 642; 48, pp. 15 and 328; 50, pp. 1-4]. PCE was detected as high as 11,000 µg/ L in the groundwater collected from monitoring wells at Sunrise Cleaners and as high as 3,900 µg/L in the groundwater collected from monitoring wells at Hockessin Cleaners [Refs. 49, pp. 5, 6, 9-11, 14, 15, 17, 20, 216, 229, 242, 256, 269, 283, 310, 329, 356, 369, 383, 410, 424, and 440; 50, pp. 1-4].

As part of the 2016 and 2017 EPA Removal Action, groundwater samples were also collected from four domestic wells and an irrigation well [Refs. 27, pp. 45 and 46; 28, p. 2; 47, pp. 5, 8, 14, 18, and 20]. As further presented at the conclusion of **Section 3.1.1** of this HRS documentation record, analytical results for the groundwater samples collected from the domestic and irrigation wells also show the presence of site-related contaminants; however, an observed release was not evaluated for the domestic and irrigation wells as part of this HRS documentation record.

As presented in **Section 3.3** of this HRS documentation record, Artesian Water Company is the primary source of drinking water in Hockessin, Delaware. Artesian supplies potable water to approximately 181,688 persons throughout Delaware as well as approximately 2,726 persons in Elkton, Maryland. Artesian Water Company's source water is primarily groundwater obtained from 51 wells throughout New Castle County, six of which are located in Hockessin [Refs. 7, p. 26; 26, p. 21]. Artesian also purchases surface water from Chester Water Authority and the City of Wilmington, Delaware to supplement the groundwater and sells finished water to the Town of Elkton [Refs. 26, pp. 25 and 26; 52, p. 1]. Additionally, 14 domestic wells within 0.25 mile of the site have been identified [Ref. 9, p. 14].

PCE is a man-made compound commonly used in commercial/industrial operations such as dry cleaning, metal degreasing, and manufacturing of other chemicals; it is also used in some consumer products [Ref. 21, p. 1]. As further presented in **Section 2.2** of this HRS documentation record, two dry-cleaning facilities have documented PCE soil contamination.



Delaware

USGS 7.5 Minute Quadrangle
Kennett Square PA/DE, 1973. Revised 1974

N

Coordinate System:
WGS84 UTM Zone 18N Feet

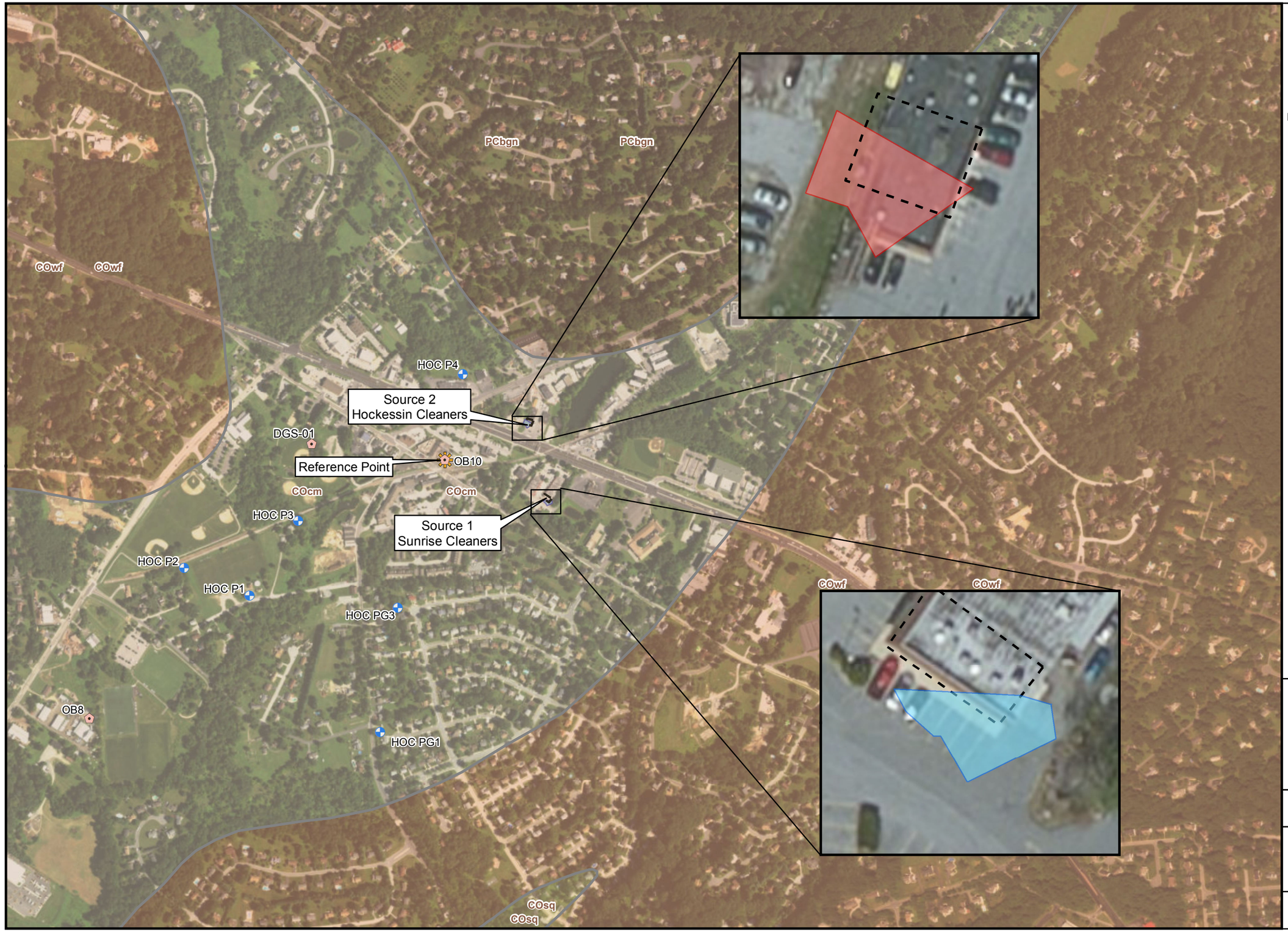
0 1,250 2,500
Feet

Hockessin Groundwater
Hockessin, New Castle County, Delaware

Figure 1
Site Location Map

TDD#: W503-16-06-001
Contract: EP-S3-15-02
Prepared: 9/8/2017

WESTON SOLUTIONS



Legend

- Site Reference Point – Hockessin Groundwater
- Public Supply Wells
- Observation Wells
- Dry-Cleaning Facilities
- Source 1
- Source 2

Geological Unit

- PCbgn - Baltimore Gneiss, Precambrian
- COcm - Cockeysville Marble, Cambrian-Ordovician
- COsq - Setters Formation, Cambrian-Ordovician
- COwf - Wissahickon Formation, Cambrian-Ordovician

Note:
The Cockeysville Marble is a state designated Wellhead Protection Area

Reference: 46, 56, 10, pp. 19, 20, 40-48; 14, pp. 21, 22, and 37

Imagery:
ESRI, Imagery Mapping Service, 2015.
The source of this map image is Esri, used by the EPA with Esri's permission

Geology layer: Delaware Geological Survey, 2005

Coordinate System:
WGS84 UTM Zone 18N Feet

N

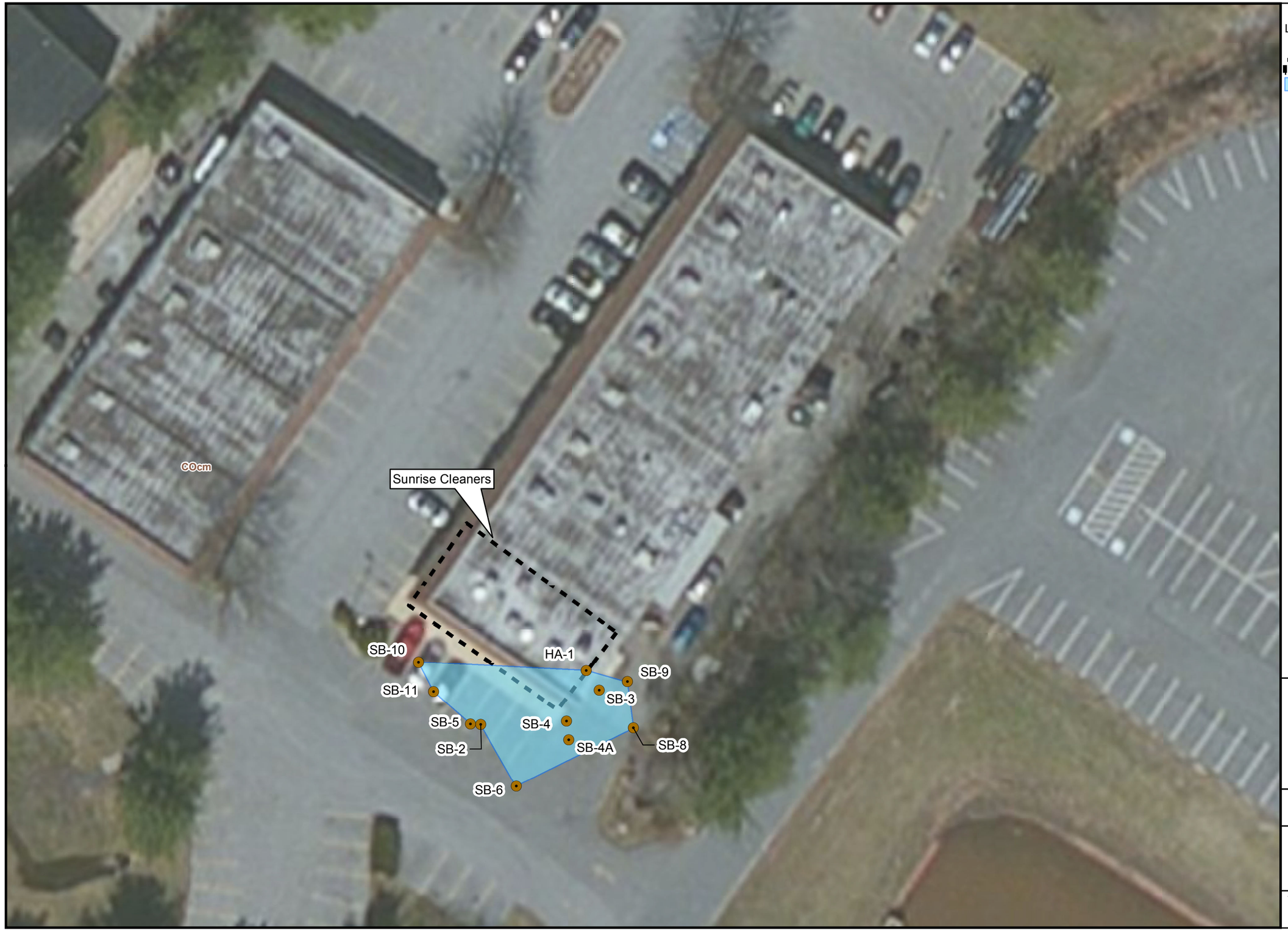
0 360 720
Feet

Hockessin Groundwater
Hockessin, New Castle County, Delaware

Figure 2
Site Layout Map

TDD#: W503-16-06-001
Contract: EP-S3-15-02
Prepared: 11/27/2017

WESTON SOLUTIONS



Legend

- Soil Sampling Locations
- Sunrise Cleaners
- Source 1

Note:
Samples collected in August 2012 and June 2013.

Reference: 10, pp. 20, 34, 42, 43, 44; 11, p. 207; 41, pp. 9, 10, 14, 17, 20, 23, 26, 107, 115, 124, 130, 136; 42, pp. 7, 10, 13, 16, 19, 22, 77, 90, and 105; 43, pp. 6, 9, 12, 15, 21, 24, 75, 82, 88, 102, and 109; 44, pp. 7, 10, 13, 62, 68

Imagery:
ESRI, Imagery Mapping Service, 2015.
The source of this map image is Esri, used by the EPA with Esri's permission

Coordinate System:
WGS84 UTM Zone 18N Feet

N

0 15 30
Feet

Hockessin Groundwater
Hockessin, New Castle County, Delaware

Figure 3
Source 1
Sample Location Map

TDD#: W503-16-06-001
Contract: EP-S3-15-02
Prepared: 9/8/2017

WESTON SOLUTIONS

Legend

- Soil Sampling Locations
- Hockessin Cleaners
- Source 2

Note:
Samples collected in April 2015.

Reference: 14, pp. 21, , 22, 26-30, 51-61; 66-68, 70, 72, 74-76, 86, 112, 236, 239, 242, 245, 248, 251, 257, 520, 523, 526, 529, 532, 535, 538, 541, 301, 307, 314, 321, 328, 335, 347, 587, 595, 601, 608, 615, 620, 628, and 636

Imagery:
ESRI, Imagery Mapping Service, 2015. The source of this map image is Esri, used by the EPA with Esri's permission

Coordinate System:
WGS84 UTM Zone 18N Feet

N

0 15 30
Feet

Hockessin Groundwater
Hockessin, New Castle County, Delaware

Figure 4
Source 2
Sample Location Map

TDD#: W503-16-06-001
Contract: EP-S3-15-02
Prepared: 9/8/2017

WESTON SOLUTIONS

Legend

- Site Reference Point – Hockessin Groundwater
- Public Supply Wells
- Monitoring Wells
- Observation Wells
- Dry-Cleaning Facilities
- Source 1
- Source 2
- Contaminated Groundwater Plume

Note:
Samples collected in September 2016.

Reference: 56, 29, pp. 8, 9, 12-15, 36-41, 110, 111, 132, 145, 157, 188, 189, 198, 211, 221, 234; 30, pp. 5-8, 77, 90, 100, and 113; 37, pp. 1-4; 47, pp. 22, 224, 225; 48, pp. 5, 7, 46, 47, 56 and 57; 49, pp. 9-12, 14, 16, 18, 20, 21, 241, 242, 256, 268, 283, 296, 297, 309, 329, 341, 356, 368, 383, 395, 410, 423, and 440; 50, pp. 1-4

Imagery:
ESRI, Imagery Mapping Service, 2015.
The source of this map image is Esri, used by the EPA with Esri's permission

Coordinate System:
WGS84 UTM Zone 18N Feet

N

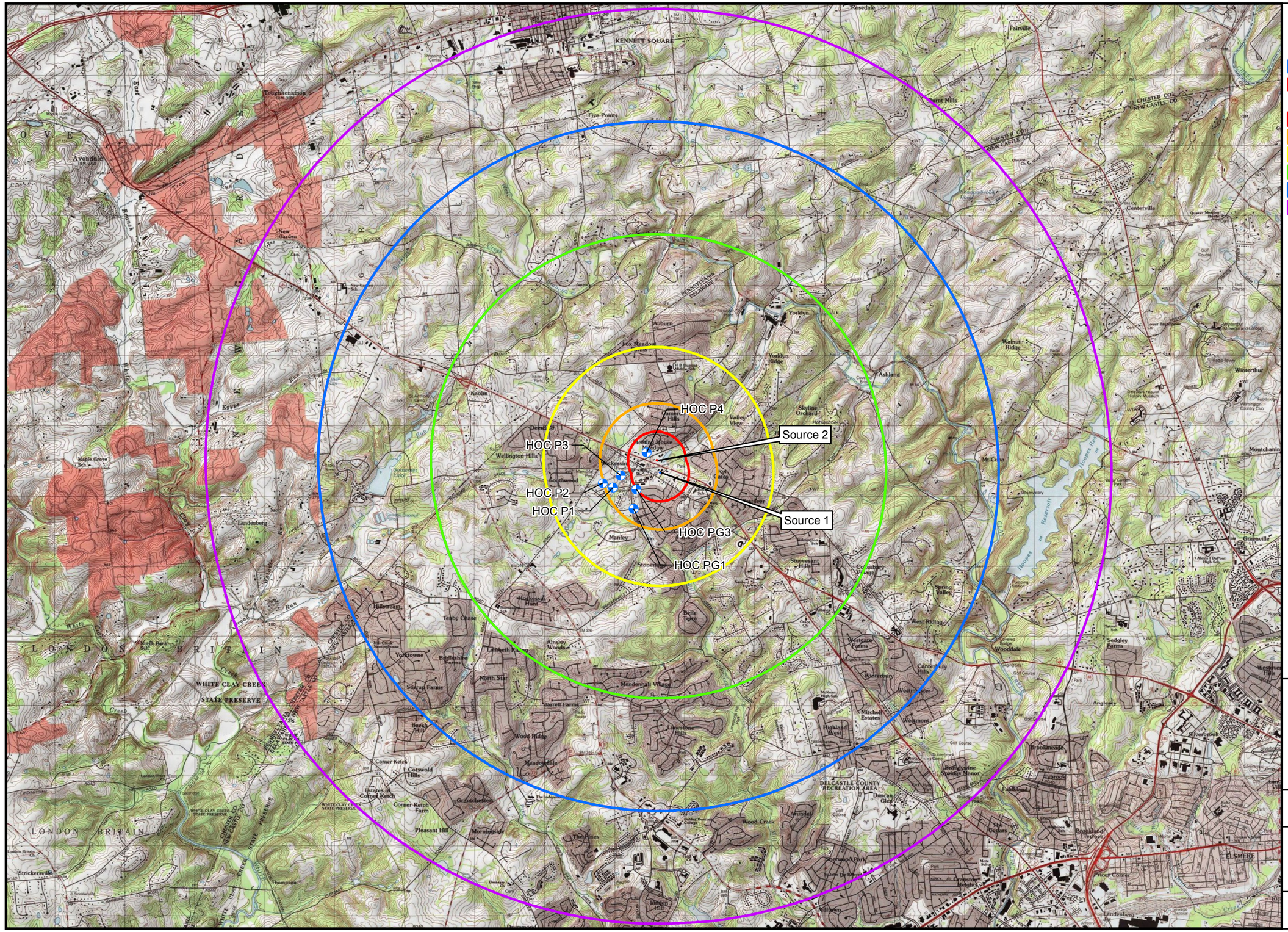
0 345 690
Feet

Hockessin Groundwater
Hockessin, New Castle County, Delaware

Figure 5
Ground Water Sample Locations

TDD#: W503-16-06-001
Contract: EP-S3-15-02
Prepared: 10/11/2017

WESTON SOLUTIONS



Legend

- Public Supply Wells
- Source 1
- Source 2

Distance Buffers

- 0.25 Miles
- 0.5 Miles
- 1 Miles
- 2 Miles
- 3 Miles
- 4 Miles

Reference: 10, pp. 20, 34, 42, 43, 44; 11, p. 207; 41, pp. 9, 10, 14, 17, 20, 23, 26, 107, 115, 124, 130, 136; 42, pp. 7, 10, 13, 16, 19, 22, 77, 90, and 105; 43, pp. 6, 9, 12, 15, 21, 24, 75, 82, 88, 102, and 109; 44, pp. 7, 10, 13, 62, 68
Reference: 14, pp. 21, 22, 26-30, 51-61; 66-68, 70, 72, 74-76, 86, 112, 236, 239, 242, 245, 248, 251, 257, 520, 523, 526, 529, 532, 535, 538, 541, 301, 307, 314, 321, 328, 335, 347, 587, 595, 601, 608, 615, 620, 628, and 636
Reference 56, pp. 1-2

Imagery: USGS 7.5 -Minute Series Topographic Quadrangles
The source of this map image is Esri, used by the EPA with Esri's permission

Coordinate System: WGS84 UTM Zone 18N Feet

N

0 0.2 0.4 0.8
Miles

Hockessin Groundwater
Hockessin, New Castle County, Delaware

Figure 6
4-mile Radius Map with Distance Rings

TDD#: W503-16-06-001
Contract: EP-S3-15-02
Prepared: 10/11/2017

WESTON SOLUTIONS

SOURCE DESCRIPTION

2.2 SOURCE CHARACTERIZATION

Number of the source: 1

Source Type of the source: Contaminated Soil

Name and description of the source: Contaminated Soil - Sunrise Cleaners

Source 1 is an undefined volume of VOC-contaminated soil in the vicinity of Sunrise Cleaners located in the Shoppes of Hockessin that has resulted from the migration, deposition, or spillage of hazardous substances associated with dry-cleaning activities conducted on the property. As previously stated, the property owner of the Sunrise Cleaners location was issued a Notice of Violation (NOV) from DNREC in 1989 for the disposal of hazardous waste in an unlawful manner, namely disposal of material into a dumpster outside of the building [Ref. 5, p. 1]. In 1989, during a preliminary environmental assessment, the owner/operator of Sunrise Cleaners stated that PCE was used in the dry cleaning process and that spent filters were drained into the machines for several days, then discarded into a dumpster located outside of the building awaiting off-site disposal [Ref. 6, pp. 3 and 9]. The preliminary environmental assessment noted the location of the dumpster outside of the dry-cleaning facility and observed staining on the ground surface underneath and in the vicinity of the dumpster [Ref. 6, p. 9].

In August 2012, soil samples were collected from the Shoppes of Hockessin by the property owner as part of a due diligence for refinancing [Ref. 10, p. 4]. One shallow and four deep soil borings ranging in depth from 3.2 to 21.5 feet bgs were advanced as part of the investigation [Ref. 11, pp. 15-19]. Analytical results for collected soil samples indicated the presence of PCE in the shallow soil boring and in three of the deep borings, up to a maximum concentration of 30,000,000 µg/kg in a soil sample collected at 19.5 feet bgs [Ref. 11, pp. 11, 13, 32, 34, 36, and 38]. In June 2013, under the DNREC VCP, the property owner conducted a soil investigation in the vicinity of Sunrise Cleaners to determine the extent of PCE in soil on the property [Ref. 10, p. 3]. As part of the investigation, eight soil borings were advanced ranging in depth from 24 to 50.5 bgs [Ref. 10, pp. 20, 40-48]. The borings were advanced using hollow-stem augers, and soil samples were retrieved using a continuous split-spoon sampling technique [Ref. 10, p. 9]. The split-spoon cores were field-screened with a photo ionization detector (PID) and logged every 4 feet [Ref.10, pp. 9, 40-48]. A total of 67 soil samples were collected from the eight soil borings, ranging in depth from 2.2 to 32.5 feet bgs at approximately 4-foot intervals, and submitted to the DNREC laboratory for screening [Ref. 10, pp. 9, 11, and 29-32]. A total of 20 of the 67 collected soil samples were then submitted to Test America Laboratories, Inc. for confirmatory VOCs analysis in accordance with EPA Method 8260B [Refs. 10, p. 33; 41, p. 7; 42, p. 4; 43, p. 4; 44, p. 4]. As presented further in **Section 2.2.2** of this HRS documentation record, PCE and PCE breakdown products (TCE and DCE) were detected in the collected soil samples at depths ranging from 2.2 to 32.5 feet bgs [Refs. 8, pp. 2 and 3; 10, p. 34]. PCE was detected as high as 11,000 µg/kg, TCE as high as 300 µg/kg, and DCE as high as 1,300 µg/kg [Refs. 10, pp. 34, 42, 43, and 44; 41, pp. 9, 10, 14, 17, 20, 23, 26, 107, 115, 124, 130, and 136; 42, pp. 7, 10, 13, 16, 19, 22, 77, 90, and 105; 43, pp. 6, 9, 12, 15, 21, 24, 75, 82, 88, 102, and 109; 44, pp. 7, 10, 13, 62, and 68]. Background soil samples were not collected as part of the investigations at Sunrise Cleaners; however, the substances scored are not naturally occurring, dry cleaning operations are associated with PCE, and PCE breakdown products include TCE, cis-1,2-DCE, and vinyl chloride [Refs. 8, pp. 2 and 3; 21, p. 1].

Location of the source, with reference to a map of the site:

Source 1, as currently documented, is located along the southern and eastern portion of the building that contains Sunrise Cleaners. The source location is shown on **Figure 2** of the HRS documentation record.

Containment

Release to groundwater:

Source 1 is in direct contact with groundwater. Analytical results for collected soil samples document contamination to a depth of 32.5 feet bgs [Refs. 10, pp. 34, 42, 43, and 44; 41, pp. 9, 10, 14, 17, 20, 23, 26, 107, 115, 124, 130, and 136; 42, pp. 7, 10, 13, 16, 19, 22, 77, 90, and 105; 43, pp. 6, 9, 12, 15, 21, 24, 75, 82, 88, 102, and 109; 44, pp. 7, 10, 13, 62, and 68]. Groundwater within the source area is encountered between approximately 16 and 18.5 feet bgs [Ref. 13, pp. 20, 22, and 23]. Based on evidence of hazardous substance migration (contamination detected in groundwater samples collected from on-site monitoring wells, public supply wells, and an observation well that meets the criteria for an observed release, as further presented in **Section 3.1.1** of this HRS documentation record), a containment factor of 10 is assigned [Ref. 1, Section 3.1.2.1, Table 3-2].

2.2.2 Hazardous Substances

As discussed previously, soil samples collected by the property owner under DNREC's VCP document the contaminated soil at Sunrise Cleaners (Source 1).

Presented below are the sample IDs, collection dates, depths, results, and reporting limits for hazardous substances detected in soil samples collected at Sunrise Cleaners (Source 1).

Table 1

Source No. 1 – Hazardous Substances Associated with Soil Samples

Sample ID	Depth (ft. bgs)	Date	Hazardous Substance	Concentration (µg/kg)	RL (µg/kg) *	References
HA-1	3.0-3.2	8/9/12	PCE	14,000	150	11, pp. 13, 15, 38, 107, 194
SB-2	20.5-21	8/9/12	PCE	820	140	11, pp. 13, 17, 32, 84, 194
			Cis-1,2-DCE	27J	140	11, pp. 13, 17, 32, 84, 194
SB-3	11.5-12	8/912	PCE	48,000	160	11, pp. 13, 18, 34, 92, 194
			TCE	440	160	11, pp. 13, 18, 34, 92, 194
			Cis-1,2-DCE	630	160	11, pp. 13, 18, 34, 92, 194
SB-4	19-19.5	8/9/12	PCE	30,000,000	77,000	11, pp. 13, 19, 36, 101, 194
SB-4A ES1	2.2-2.7	6/24/2013	PCE	200	160	10, p. 34, 42; 42, pp. 7, 22, 105, 230
			TCE	140J	160	10, p. 34, 42; 42, pp. 7, 22, 105, 230
SB-5 ES-1	2.0-2.5	6/19/2013	TCE	270	160	10, p. 34, 43; 43, pp. 6, 9, 75, 227
			Cis-1,2-DCE	250	160	10, p. 34, 43; 43, pp. 6, 9, 75, 227
SB-5 ES-2	6.5-7.0	6/19/2013	PCE	39J	150	10, p. 34, 42; 43, pp. 6, 12, 82, 227
SB-5 ES-5	19.0-19.5	6/19/2013	PCE	11,000	180	10, p. 34, 43; 43, pp. 6, 15, 88, 227
			TCE	96J	180	10, p. 34, 43; 43, pp. 6, 15, 88, 227
			Cis-1,2-DCE	200	180	10, p. 34, 43; 43, pp. 6, 15, 88, 227
SB-6 ES-5	21.5-22	6/19/2013	PCE	8,000	280	10, p. 34, 44; 43, pp. 6, 21, 102, 228
			TCE	32J	280	10, p. 34, 44; 43, pp. 6, 21, 102, 228
SB-6 ES-9	32-32.5	6/19/2013	PCE	7,900	160	10, p. 34, 45; 43, pp. 6, 24, 109, 228
			TCE	28J	160	10, p. 34, 45; 43, pp. 6, 24, 109, 228
			Cis-1,2-DCE	88J	160	10, p. 34, 45; 43, pp. 6, 24, 109, 228
SB-8 ES-1	3.0-3.5	6/20/2013	Cis-1,2-DCE	480	160	10, p. 34, 47; 44, pp. 7, 10, 62, 299

Table 1 (continued)

Source No. 1 – Hazardous Substances Associated with Soil Samples

Sample ID	Depth (ft. bgs)	Date	Hazardous Substance	Concentration (µg/kg)	RL (µg/kg) *	References
SB-8 ES-7	26.2-26.7	6/20/13	PCE	1,400	200	10, p. 34, 47; 44, pp. 7, 13, 68, 299
			TCE	51J	200	10, p. 34, 47; 44, pp. 7, 13, 68, 299
			Cis-1,2-DCE	210	200	10, p. 34, 47; 44, pp. 7, 13, 68, 299
SB-9 ES-2	6.2-6.7	6/21/2013	PCE	4,100	170	10, p. 34, 48; 41, pp. 9, 14, 107, 1380
			TCE	300	170	10, p. 34, 48; 41, pp. 9, 14, 107, 1380
			Cis-1,2-DCE	1,300	170	10, p. 34, 48; 41, pp. 9, 14, 107, 1380
SB-9 ES-6	22.0-22.5	6/21/2013	PCE	690	150	10, p. 34, 48; 41, pp. 10, 17, 115, 1380
			TCE	14J	150	10, p. 34, 48; 41, pp. 10, 17, 115, 1380
			Cis-1,2-DCE	46J	150	10, p. 34, 48; 41, pp. 10, 17, 115, 1380
SB-10 ES-2	7.0-7.5	6/21/2013	PCE	140J	220	10, p. 34, 40; 41, pp. 10, 20, 124, 1380
SB-10 ES-4	15.0-15.5	6/21/2013	PCE	2,300	180	10. p. 34, 40; 41, pp. 10, 23, 130, 1381
SB-10 ES-6	22.0-23.0	6/21/2013	PCE	1,100	160	10, p. 34, 40; 41, pp. 10, 26, 136, 1381
SB-11 ES-1	2.5-3.0	6/24/2013	TCE	52J	150	10, p. 34, 41; 42, p. 7, 10, 77, 230
			Cis-1,2-DCE	43J	150	10, p. 34, 41; 42, p. 7, 10, 77, 230
SB-11 ES-3	11.0-11.5	6/24/2013	PCE	2,500	170	10, p. 34, 41; 42, p. 7, 13, 84, 230
SB-11 ES-5	19.0-19.5	6/24/2013	PCE	110J	140	10, p. 34, 41; 42, p. 7, 16, 90, 230
SB-11 ES-8	24.5-25.0	6/24/2013	PCE	1,900	150	10, p. 34, 41; 42, p. 7, 19, 96, 230
			TCE	25J	150	10, p. 34, 41; 42, p. 7, 19, 96, 230
			Cis-1,2-DCE	84J	150	10, p. 34, 41; 42, p. 7, 19, 96, 230

*The limits provided are sample-specific reporting limits (RL), and are equivalent to the Sample Quantitation Limits (SQL) as defined in HRS Section 1.1, Definitions [Refs. 11, p. 25; 41, p. 6; 42, p. 4; 43, p. 4; 44, p. 4].
J - estimated value – Result is less than the RL but greater than or equal to the method detection limit (MDL) and the concentration is an approximate value. As such, adjustment factors do not apply to these J-flagged results [Refs. 11, p. 57; 40, p. 4; 41, p. 84; 42, p. 51; 43, p. 50, 44, p. 45].

2.4.2 Hazardous Waste Quantity

Insufficient information exists to evaluate hazardous constituent quantity and hazardous wastestream quantity. Therefore, the hazardous waste quantity value is calculated using Tier C, the volume of the contaminated soil [Ref. 1, Section 2.4.2.1] for Source No. 1.

2.4.2.1.1 Hazardous Constituent Quantity (Tier A)

The hazardous constituent quantity for Source No. 1 could not be adequately determined according to the HRS requirements; that is, the total mass of all CERCLA hazardous substances in the source and releases from the source is not known and cannot be estimated with reasonable confidence [Ref. 1, Section 2.4.2.1.1]. There are insufficient historical and current data (manifests, PRP records, State records, permits, waste concentration data, etc.) available to adequately calculate the total or partial mass of all CERCLA hazardous substances in the source and the associated releases from the source. Therefore, there is insufficient information to evaluate the associated releases from the source to calculate the hazardous constituent quantity for Source No. 1 with reasonable confidence. Scoring proceeds to the evaluation of Tier B, Hazardous wastestream quantity [Ref. 1, Section 2.4.2.1.1].

Hazardous Constituent Quantity (C) Value: Not scored

2.4.2.1.2 Hazardous Wastestream Quantity (Tier B)

The hazardous wastestream quantity for Source No. 1 could not be adequately determined according to the HRS requirements; that is, the mass of the hazardous wastestreams plus the mass of any additional CERCLA pollutants and contaminants in the source and releases from the source is not known and cannot be estimated with reasonable confidence [Ref. 1, Section 2.4.2.1.2]. There are insufficient historical and current data (manifests, PRP records, State records, permits, waste concentration data, etc.) available to adequately calculate the total or partial mass of the wastestream plus the mass of all CERCLA pollutants and contaminants in the source and the associated releases from the source. Therefore, there is insufficient information to evaluate the associated releases from the source to calculate the hazardous wastestream quantity for Source No. 1 with reasonable confidence. Scoring proceeds to the evaluation of Tier C, Volume [Ref. 1, Section 2.4.2.1.2].

Hazardous Wastestream Quantity (W) Value: Not scored

2.4.2.1.3 Volume (Tier C)

Based on sampling data, contaminated soil has been documented at Sunrise Cleaners. The vertical and horizontal extent of the area of contamination has not been thoroughly investigated. Documented depth of contamination ranges from 2.7 to 32.5 feet bgs in the soil borings (see **Section 2.2.2** of this HRS documentation record). The information available on the vertical extent of the soil contamination is not sufficient to support an exact or reasonably accurate volume of the contaminated soil with reasonable confidence; therefore, it is not possible to calculate a volume (Tier C) for Source No. 1 [Ref. 1, Section 2.4.2.1.3]. Therefore, for Source No. 1, a value of greater than 0 but exact amount unknown has been assigned for the source hazardous waste quantity value for volume (Ref. 1, Section 2.4.2.1.3). The source type is 'contaminated soil'; therefore, the volume value is divided by 2,500 to obtain the assigned value, as shown below [Ref. 1, Section 2.4.2.1.3, Table 2-5].

Dimension of source in cubic yards (yd^3): >0 yd^3
Volume (V) Assigned Value: (>0)/2,500 = >0

2.4.2.1.4 Area (Tier D)

The volume of the source has been determined; therefore, Tier D – area is assigned a hazardous waste quantity value of 0 [Ref. 1, Section 2.4.2.1.3, Table 2-5].

Area (A) Assigned Value: 0

2.4.2.1.5 Source Hazardous Waste Quantity Value

The source hazardous waste quantity value for Source 1 is >0 for Tier C - Volume [Ref. 1, Section 2.4.2.1.5].

Source Hazardous Waste Quantity Value: >0

SOURCE DESCRIPTION

2.2 SOURCE CHARACTERIZATION

Number of the source: 2

Source Type of the source: Contaminated Soil

Name and description of the source: Contaminated Soil- Hockessin Cleaners

Source 2 is an undefined volume of VOC-contaminated soil in the vicinity of Hockessin Cleaners located in a shopping center at 7313 Lancaster Pike. A PA conducted by DNREC in 2005 identified Hockessin Cleaners as a possible source for the VOCs, particularly PCE, detected in the public supply wells located in Hockessin, Delaware, during a 2002 Drinking Water Impact Study [Refs. 7, p. 28; 9, p. 8].

In 2015, DNREC conducted a Facility Evaluation at Hockessin Cleaners. DNREC advanced four soil borings ranging in depth from 0 to 53 feet bgs using direct push technologies (DPT) [Ref. 14, pp. 21, 22, 37, 51-61]. The soil cores were collected from the borings in 5-foot acetate sleeves that were field-screened with a PID and logged [Ref. 14, pp. 10, 51-61]. DNREC collected 79 soil samples from the soil borings as well as an additional 10 surface soil samples [Ref. 14, pp. 12, 21, and 22]. The soil samples were initially screened at a DNREC laboratory with a portable gas chromatography/mass spectroscopy (GC/MS) [Ref. 14, pp. 10, 23-25]. Of the collected samples, one surface and 17 subsurface samples, ranging in depth from 2 to 42 feet bgs, were submitted for confirmatory laboratory VOC analysis [Ref. 14, pp. 13, 26-30]. The soil samples were analyzed for VOCs by Test America Laboratories, Inc. in accordance with EPA Method 8260B [Ref. 14, pp. 78 and 84]. As presented further in **Section 2.2.2** of this HRS documentation record, PCE, as well as PCE breakdown products TCE and DCE, were detected in the collected soil samples at depths ranging from 0 to 42 feet bgs [Refs. 8, pp. 2 and 3; 14, pp. 26-30, 66-68, 70, 72, 74-76, 86, 112, 236, 239, 242, 245, 248, 251, 257, 301, 307, 314, 321, 328, 335, 347, 520, 523, 526, 529, 532, 535, 538, 541, 587, 595, 601, 608, 615, 620, 628, and 636]. Background soil samples were not collected as part of the investigation at Hockessin Cleaners; however, the substances scored are not naturally occurring, dry cleaning operations are associated with PCE, and PCE breakdown products include TCE, cis-1,2-DCE, and vinyl chloride [Refs. 8, pp. 2 and 3; 21, p. 1].

Location of the source, with reference to a map of the site:

Source 2 is located surrounding the building that contains Hockessin Cleaners. The source location and approximate area of contamination are shown on **Figure 3** of the HRS documentation record.

Containment

Release to groundwater:

Source 2 is in direct contact with groundwater. Analytical results for collected soil samples document evidence of contamination to a depth of 42 feet bgs [Ref. 14, pp. 26-30, 66-68, 70, 72, 74-76, 86, 112, 236, 239, 242, 245, 248, 251, 257, 301, 307, 314, 321, 328, 335, 347, 520, 523, 526, 529, 532, 535, 538, 541, 587, 595, 601, 608, 615, 620, 628, and 636]. Groundwater within the source area is encountered between 27 and 30 feet bgs [Ref. 20, pp. 15-17]. Based on evidence of hazardous substance migration (contamination detected in groundwater samples collected from on-site monitoring wells, public supply wells, and an observation well that meets the criteria for an observed release, as further presented in **Section 3.1.1** of this HRS documentation record), a containment factor of 10 is assigned [Ref. 1, Section 3.1.2.1, Table 3-2].

2.2.2 Hazardous Substances

As discussed previously, soil samples collected by DNREC document contaminated soil at Hockessin Cleaners (Source 2).

Presented below are the sample IDs, collection dates, depths, results, and the reporting limits for hazardous substances detected in soil samples collected at Hockessin Cleaners (Source 2).

Table 2

Source No. 2 – Hazardous Substances Associated with Soil Samples

Sample ID	Depth (ft. bgs)	Date	Hazardous Substance	Concentration (µg/kg)	RL (µg/kg) *	References
HSC-SS09	0-1	3/30/2015	PCE	1,100H	110	14, pp. 26, 66, 86, 112
HCS-SB01	0-2	4/06/2015	PCE	260	82	14, pp. 27, 51, 67, 236, 301
HCS-SB01	4-6	4/06/2015	PCE	1,200	80	14, pp. 27, 51, 67, 239, 307
			TCE	19J	80	14, pp. 27, 51, 67, 239, 307
HCS-SB01	8-10	4/6/2015	PCE	1,800	72	14, pp. 27, 51, 67, 242, 314
			TCE	25J	72	14, pp. 27, 51, 67, 242, 314
HCS-SB01	12-14	4/6/2015	PCE	1,600	74	14, pp. 27, 51, 67, 245, 321
			TCE	36J	74	14, pp. 27, 51, 67, 245, 321
HCS-SB01	18-20	4/6/2015	PCE	1,400	73	14, pp. 27, 51, 67, 248, 328
			TCE	35J	73	14, pp. 27, 51, 67, 248, 328
HCS-SB01	22-24	4/6/2015	PCE	3,000	81	14, pp. 27, 52, 68, 251, 335
			TCE	34J	81	14, pp. 27, 52, 68, 251, 335
HCS-SB02	40-42	4/6/2015	PCE	57J	68	14, pp. 28, 55, 70, 257, 347
			Cis-1,2-DCE	23J	68	14, pp. 28, 55, 70, 257, 347
HCS-SB03	6-8	4/6/2015	PCE	130	120	14, pp. 28, 56, 72, 520, 587
			TCE	63J	120	14, pp. 28, 56, 72, 520, 587
			Cis-1,2-DCE	57J	120	14, pp. 28, 56, 72, 520, 587
HCS-SB04	0-2	4/6/2015	PCE	94J	110	14, pp. 29, 59, 74, 523, 595
HCS-SB04	6-8	4/6/2015	PCE	400	83	14, pp. 29, 59, 74, 526, 601
			Cis-1,2-DCE	520	83	14, pp. 29, 59, 74, 526, 601
HCS-SB04	8-10	4/6/2015	PCE	53J	110	14, pp. 29, 59, 74, 529, 608
HCS-SB04	18-20	4/6/2015	Cis-1,2-DCE	67J	170	14, pp. 29, 59, 75, 532, 615

Table 2 (continued)

Source No. 2 – Hazardous Substances Associated with Soil Samples

Sample ID	Depth (ft. bgs)	Date	Hazardous Substance	Concentration (µg/kg)	RL (µg/kg) *	References
HCS-SB04	22-24	4/6/2015	PCE	620	150	14, pp. 29, 60, 75, 535, 620
			TCE	130J	150	14, pp. 29, 60, 75, 535, 620
			Cis-1,2-DCE	190	150	14, pp. 29, 60, 75, 535, 620
HCS-SB04	24-26	4/6/2015	PCE	360	130	14, pp. 29, 60, 75, 538, 628
			TCE	84J	130	14, pp. 29, 60, 75, 538, 628
			Cis-1,2-DCE	150	130	14, pp. 29, 60, 75, 538, 628
HCS-SB04	40-42	4/6/2015	PCE	88J	110	14, pp. 29, 60, 76, 541, 636
			Cis-1,2-DCE	33J	110	14, pp. 29, 60, 76, 541, 636

*The limits provided are sample-specific RLs, and are equivalent to the Sample Quantitation Limits (SQL) as defined in HRS Section 1.1, Definitions [Ref. 14, pp. 81, 231, and 511].
H – estimated value – the sample was prepped and analyzed beyond the holding time [Ref. 14, p. 98].
J - estimated value – Result is less than the RL but greater than or equal to the MDL and the concentration is an approximate value. As such, adjustment factors do not apply to these J-flagged results [Refs. 14, pp. 275 and 563; 40, p. 4].

2.4.2 Hazardous Waste Quantity

Insufficient information exists to evaluate hazardous constituent quantity and hazardous wastestream quantity. Therefore, the hazardous waste quantity value is calculated using Tier C, the volume of the contaminated soil [Ref. 1, Section 2.4.2.1] for Source No. 2.

2.4.2.1.1 Hazardous Constituent Quantity (Tier A)

The hazardous constituent quantity for Source No. 2 could not be adequately determined according to the HRS requirements; that is, the total mass of all CERCLA hazardous substances in the source and releases from the source is not known and cannot be estimated with reasonable confidence [Ref. 1, Section 2.4.2.1.1]. There are insufficient historical and current data (manifests, PRP records, State records, permits, waste concentration data, etc.) available to adequately calculate the total or partial mass of all CERCLA hazardous substances in the source and the associated releases from the source. Therefore, there is insufficient information to evaluate the associated releases from the source to calculate the hazardous constituent quantity for Source No. 2 with reasonable confidence. Scoring proceeds to the evaluation of Tier B, Hazardous wastestream quantity [Ref. 1, Section 2.4.2.1.1].

Hazardous Constituent Quantity (C) Value: Not scored

2.4.2.1.2 Hazardous Wastestream Quantity (Tier B)

The hazardous wastestream quantity for Source No. 2 could not be adequately determined according to the HRS requirements; that is, the mass of the hazardous wastestreams plus the mass of any additional CERCLA pollutants and contaminants in the source and releases from the source is not known and cannot be estimated with reasonable confidence [Ref. 1, Section 2.4.2.1.2]. There are insufficient historical and current data (manifests, PRP records, State records, permits, waste concentration data, etc.) available to adequately calculate the total or partial mass of the wastestream plus the mass of all CERCLA pollutants and contaminants in the source and the associated releases from the source. Therefore, there is insufficient information to evaluate the associated releases from the source to calculate the hazardous wastestream quantity for Source No. 2 with reasonable confidence. Scoring proceeds to the evaluation of Tier C, Volume [Ref. 1, Section 2.4.2.1.2].

Hazardous Wastestream Quantity (W) Value: Not scored

2.4.2.1.3 Volume (Tier C)

Based on sampling data, contaminated soil has been documented at Hockessin Cleaners. The vertical and horizontal extent of the area of contamination has not been thoroughly investigated. Documented depth of contamination ranges from 0-2 feet to 40-42 feet bgs in the soil borings (see **Section 2.2.2** of this HRS documentation record). The information available on the vertical extent of the soil contamination is not sufficient to support an exact or reasonably accurate volume of the contaminated soil with reasonable confidence; therefore, it is not possible to calculate a volume (Tier C) for Source No. 2 [Ref. 1, Section 2.4.2.1.3]. Therefore, for Source No. 2, a value of greater than 0 but exact amount unknown has been assigned for the source hazardous waste quantity value for volume (Ref. 1, Section 2.4.2.1.3). The source type is 'contaminated soil'; therefore, the volume value is divided by 2,500 to obtain the assigned value, as shown below [Ref. 1, Section 2.4.2.1.3, Table 2-5].

Dimension of source in cubic yards (yd^3): >0 yd^3
Volume (V) Assigned Value: (>0)/2,500 = >0

2.4.2.1.4 Area (Tier D)

The volume of the source has been determined; therefore, Tier D – area is assigned a hazardous waste quantity value of 0 [Ref. 1, Section 2.4.2.1.3, Table 2-5].

Area (A) Assigned Value: 0

2.4.2.1.5 Source Hazardous Waste Quantity Value

The source hazardous waste quantity value for Source 2 is >0 for Tier C - Volume [Ref. 1, Section 2.4.2.1.5].

Source Hazardous Waste Quantity Value: >0

Table 3

Site Summary of Source Descriptions

Source Number	Source Hazardous Waste Quantity Value	Source Hazardous Constituent Quantity Complete (Y/N)	Containment			
			Ground Water	Surface Water	Air (Gas)	Air (Particulate)
1	>0	N	10	NS	NS	NS
2	>0	N	10	NS	NS	NS

NS = Not scored.

Other Possible Sources

No other possible sources have been identified at the site.

3.0 GROUND WATER MIGRATION PATHWAY

3.0.1 General Considerations

The site lies within the Piedmont Physiographic Province [Refs. 32, p. 1; 33, p. 8; 34, pp. 4 and 5]. The rocks of the Piedmont Province in Delaware, in descending order, include Wilmington Complex, Wissahickon Formation, Cockeysville Formation (a.k.a Cockeysville Marble), Setters Formation, and Baltimore Gneiss; however, the Setters Formation has not been found in the Hockessin area [Refs. 33, pp. 12 and 32; 34, pp. 4 and 5]. A major regional deformation occurred during the Taconic Orogeny when the North American basement (Baltimore Gneiss) and its sedimentary cover collided with a volcanic arc (Wilmington Complex) [Refs. 33, p. 10; 34, pp. 14, 26, and 29]. During this collision, the rocks were highly metamorphosed, folded to form basement-cored anticlines or nappes, and stacked by a series of thrusts [Ref. 33, p. 10]. The contaminated public supply wells in Hockessin withdraw water from the Cockeysville Formation; therefore, the aquifer being evaluated consists of the Cockeysville Formation and overlying saprolite (see below and **Section 3.1.1**).

The site is situated on the southeastern side of the Hockessin-Yorklyn anticline of the Mill Creek Nappe and it is underlain by the Cockeysville Formation [**Figure 2**; Refs. 32, p. 2; 33, pp. 7 and 65; 34, pp. 5, 6, 9, and 10]. The Cockeysville Formation has no internal stratigraphy; however, three lithologies, dolomite marble, calcite marble, and calc-schist, have been identified in well cores and quarries. Dolomite marble is the dominant lithology and makes up about 90 percent of the Cockeysville Formation in the Mill Creek Nappe. The dolomite marble occurs as a pure, coarsely crystalline, blue-white marble that locally contains streaks or thin bands of calc-silicate minerals. Blue-white calcite marble is present in thin irregular layers within the dolomite marble. Layers of phlogopite usually define the contacts between the rock types. Calc-schist is a fine- to medium-grained, light-gray rock that is phlogopite-rich and strongly foliated [Ref. 34, p. 10]. Gamma-logs from wells drilled into the Cockeysville indicate that the calc-schist is most common in the upper 250 feet of the formation [Ref. 33, p. 16]. The total thickness of the Cockeysville Formation in Hockessin, Delaware, is estimated to be between 400 and 800 feet, based on outcrop and structural interpretations [Refs. 33, p. 27; 34, pp. 6, 9, and 10]. The Cockeysville Formation is characterized as karstic, which is distinguished by sinkholes, caves, well-developed subsurface drainage systems, and solution cavities [Refs. 33, pp. 18 and 19; 35, pp. 2 and 9; 39, pp. 1-3].

Structurally, the Hockessin-Yorklyn valley (i.e., the general site location) lies on the upper limb of a large anticline or nappe that is cored by Baltimore Gneiss and overturned to the northwest. Test wells drilled on the southeast side of the valley found Baltimore Gneiss, Cockeysville Formation, and Wissahickon Formation dipping moderately to the southeast in a normal stratigraphic sequence. Southwest of Hockessin, the Cockeysville Formation ends abruptly against a dextral strike-slip fault [Refs. 33, p. 27; 34, pp. 6-7]. The northwestern boundary of the Hockessin-Yorklyn anticline is a thrust fault bringing Baltimore Gneiss over the Wissahickon Formation to the northwest [Ref. 34, pp. 6 and 7]. The southeastern boundary of the anticline is an unconformity [Ref. 34, pp. 6 and 7]. Lithologies of the Baltimore Gneiss in the Mill Creek Nappe consist of granitic gneiss, hornblende-biotite gneiss, and amphibolite [Ref. 34, pp. 6 and 7]. The Wissahickon Formation is an extensive sequence of pelitic and psammitic gneisses interlayered with amphibolites [Ref. 34, p. 10]. Rocks of the Wissahickon Formation and Baltimore Gneiss function as groundwater flow barriers with little or no interchange of water between these formations and the Cockeysville Formation [Ref. 33, p. 5].

Aquifer/Stratum 1 (shallowest)

Stratum Name: Saprolite/Regolith (weathered material)

Description: The top stratum underlying the site is saprolite (a.k.a. regolith), which is composed of layers and lenses of sand, silt, and clay formed by weathering and separation of cleavages in the dolomite marble [Refs. 10, pp. 40-48; 14, pp. 51-61; 20, pp. 9-11; 32, p. 3; 33, pp. 16 and 33; 36, pp. 3, 4, 6, and 7; 39, pp. 1-3]. Saprolite overlying the fractured rocks of the Cockeysville Formation ranges in thickness from approximately 30 to 110 feet, with an average thickness of 50 to 75 feet [Refs. 10, pp. 40-48; 14, pp. 51-61; 20, pp. 9-11; 28, p. 2; 33, p. 16; 36, pp. 2, 3, 4, 6, 7, and 8; 39, pp. 1-3]. The saprolite functions as a storage reservoir that receives recharge and releases water to fractures in the underlying rock [Ref. 33, p. 33]. Groundwater is encountered within the saprolite at the source locations at depths ranging from about 15 to 30 feet bgs [Refs. 10, p. 7; 13, pp. 23, 28-33; 20, pp. 9-17].

In the regolith, groundwater flows through interstices between individual grains, from topographically higher areas towards streams in topographically lower areas, essentially towards Mill Creek, which then flows from the northwest towards the southeast, bisecting the site [Refs. 4; 33, pp. 39 and 41]. Additionally, groundwater flow direction in the regolith may also be impacted by groundwater withdrawals that have greatly lowered water table levels in the regolith and Cockeysville Aquifer [Ref. 33, p. 39]. Shallow groundwater at Source 1 has been measured to flow in a northwesterly direction [Ref. 13, pp. 17 and 18]. Based on groundwater elevation data at Source 2, shallow groundwater would flow northwesterly [Ref. 20, pp. 15, 16, and 17].

Aquifer/Stratum 2

Stratum Name: Cockeysville Formation

Description: The Cockeysville Formation underlies the saprolite at the site [**Figure 2**; Refs. 32, p. 2; 33, pp. 7 and 65; 34, pp. 6 and 34]. Available well logs for the public supply wells in Hockessin indicate that the fractured rocks of the Cockeysville Formation are encountered between about 30 and 110 feet bgs [Ref. 36, pp. 3, 5, 7, and 8]. The Cockeysville Formation transmits groundwater through fractures and solution openings that can have a transmissivity rate of 10,000 to 40,000 gallons per foot per day [Refs. 32, p. 2; 33, p. 32]. Caliper logs for wells drilled into the Cockeysville Formation show deviations that indicate where the well intersects fractures or solution openings [Ref. 33, p. 34]. In some wells, the entire thickness of the aquifer that has been penetrated is highly fractured, whereas in other wells, only a few openings are encountered [Refs. 33, p. 34; 39, pp. 1-3]. Fractures in the formation are commonly enlarged by dissolution of carbonate rocks, forming highly permeable conduits that can store and transmit large quantities of water [Ref. 33, p. 34]. Geophysical logs show that beneath the fracture zone, the Cockeysville Formation contains large solution cavities that act as important storage reservoirs for groundwater. The fracture zone is an important part of the aquifer and is also a source of recharge to solution cavities in the unfractured marble beneath [Refs. 33, pp. 18, 19, and 27; 39, pp. 1-3].

In the unweathered part of the aquifer, groundwater flows through fractures and solution openings; therefore, groundwater flow directions are affected by the orientation of the fractures and solution openings. However, due to the long-term groundwater withdrawal from the aquifer, groundwater flow is towards groundwater pumping centers, including the Hockessin public supply wells [Ref. 33, pp. 39 and 41].

3.0.1.2 Aquifer Boundaries

3.0.1.2.1 Aquifer Interconnections

The Cockeysville aquifer consists of both saprolite and fractured bedrock [Ref. 33, p. 32]. Although saprolite typically has different hydrologic characteristics from fractured rock, the saprolite and underlying Cockeysville bedrock are considered to be of the same aquifer because they are in direct contact and they respond to stresses as a single unconfined aquifer [Ref. 33, p. 32]. The saprolite receives water from precipitation and induced streamflow infiltration and provides recharge to the underlying Cockeysville Formation [Ref. 32, pp. 3 and 4]. The fracture zone is an important part of the aquifer and is also a source of recharge to solution cavities in the unfractured marble beneath [Ref. 33, pp. 18, 19, and 27]. Additionally, non-naturally occurring contaminants (PCE, TCE, and cis-1,2-DCE), typically associated with dry-cleaning facilities, have migrated through the saprolite to the underlying bedrock, as documented in **Section 3.1.1** of this HRS documentation record. The presence of site contaminants in the shallow monitoring wells located at the Sources at depths ranging from 15.5 to 52 feet bgs, and the subsequent presence of the same contaminants in the Cockeysville Formation, as documented by samples collected from public and observation wells at depths ranging from 32 to 325 feet bgs, demonstrate that the overlying saprolite and the underlying Cockeysville Formation are interconnected.

For HRS purposes, the saprolite and Cockeysville formation are evaluated as one aquifer, referred to as the Cockeysville aquifer in this HRS documentation record.

Groundwater flow in the Cockeysville aquifer is limited by lithologic and hydrologic boundaries [Ref. 33, p. 36]. Although the Cockeysville Formation extends laterally in the shallow subsurface beyond its mapped contact with other formations (noncarbonate aquifers), the degree of fracturing and dissolution is greatest in the outcrop area [Ref. 33, p. 36]. The lateral boundary of the Cockeysville aquifer, therefore, coincides with the formational outcrop

[Ref. 33, pp. 36 and 65]. The transmissivity of the Cockeysville Formation is 5 to 40 times greater than in the Wissahickon Formation and the Baltimore Gneiss, which have similar water-yielding characteristics [Ref. 32, pp. 2 and 32].

3.0.1.2.2 Aquifer Discontinuities

As previously stated in **Section 3.0.1.2.1**, the Cockeysville Aquifer is of limited extent in the vicinity of the site based on lithologic and hydrologic boundaries; however, there are no aquifer discontinuities such as faults, mountain ranges, intrusive formations such as dikes or sills, or large water bodies that entirely transect the aquifer within the target distance limit (TDL) [Refs. 33, p. 36; 34, pp. 6 and 24].

Table 4

Summary of Aquifer(s) Being Evaluated

Aquifer No.	Aquifer Name	Is Aquifer Interconnected with Upper Aquifer within 2 miles? (Y/N/NA)	Is Aquifer Continuous within 4-mile TDL? (Y/N)	Is Aquifer Karst? (Y/N)
1	Cockeysville aquifer (i.e., saprolite/Cockeysville bedrock)	Y	N	Y

TDL = target distance limit

3.1 LIKELIHOOD OF RELEASE

Groundwater samples collected in 2016 and 2017 document the contamination and demonstrate the observed releases to groundwater, as described below. Observed releases are documented separately at the Sunrise Cleaners facility and at the Hockessin Cleaners facility, and a commingled release attributable to both facilities is documented for the combined site.

PCE is a man-made compound commonly used in commercial/industrial operations such as dry cleaning, metal degreasing, and manufacturing of other chemicals; it is also used in some consumer products [Ref. 21, p. 1]. An observed release is established if the background concentration is not detected (or is less than the detection limit) and the sample measurement equals or exceeds the sample quantitation limit and the background detection limit. If detected in the background sample, an observed release is established when the sample measurement is 3 times or more above the background concentration [Ref. 1, Section 2.3, Table 2-3].

3.1.1 Observed Release

As presented in **Section 3.0.1.2.1** of this HRS documentation record, the overlying saprolite and the underlying Cockeysville formation are hydraulically interconnected and are considered one hydrologic unit in this HRS documentation record, referred to as the Cockeysville aquifer.

Aquifer Being Evaluated: Cockeysville aquifer

Direct Observation

Observed releases to groundwater by direct observation are established by demonstrating that material containing hazardous substances has been deposited or otherwise has come to be located below the top of the aquifer at both sources.

Source 1 (contaminated soil at Sunrise Cleaners) is in direct contact with groundwater. Analytical results for collected soil samples document PCE contamination, and its breakdown products TCE and cis-1,2-DCE, at depths ranging from 2 to 32.5 feet bgs [Refs. 10, pp. 34, 42, 43, 44, and 45; 41, pp. 9, 10, 14, 17, 20, 23, 26, 107, 115, 124, 130, and 136; 42, pp. 7, 10, 13, 16, 19, 22, 77, 90, and 105; 43, pp. 6, 9, 12, 15, 21, 24, 75, 82, 88, 102, and 109; 44, pp. 7, 10, 13, 62, and 68]. The top of the water table within the saprolite portion of the aquifer in Source 1 is encountered between approximately 16 and 18.5 feet bgs [Ref. 13, pp. 20, 22, and 23].

Source 2 (contaminated soil at Hockessin Cleaners) is in direct contact with groundwater. Analytical results for collected soil samples document PCE contamination, and its breakdown products TCE and cis-1,2-DCE, at depths ranging from 0 to 42 feet bgs [Ref. 14, pp. 26-30; 66-68, 70, 72, 74-76, 86, 112, 236, 239, 242, 245, 248, 251, 257, 520, 523, 526, 529, 532, 535, 538, 541, 301, 307, 314, 321, 328, 335, 347, 587, 595, 601, 608, 615, 620, 628, and 636]. The top of the water table within the saprolite portion of the aquifer in Source 2 is encountered between 27 and 30 feet bgs [Ref. 20, pp. 6, 15-17].

Chemical Analysis

An observed release by chemical analysis is established by demonstrating that the hazardous substance in release samples are significantly greater in concentration than in the background samples and by documenting that at least part of the significant increase is due to a release from the site being evaluated. The significant increase can be documented in one of two ways for HRS purposes. If the background concentration is not detected, an observed release is established when the sample measurement in a similar sample equals or exceeds the appropriate quantitation limit. If the background sample concentration equals or exceeds the detection limit, an observed release is established when the sample measurement in a similar sample is three times or more the background concentration and above the appropriate quantitation limit [Ref. 1, Section 2.3]. All hazardous substances in the groundwater observed release tables meet these criteria.

Chemical analysis for groundwater samples collected from Artesian public supply wells and observation wells located in Hockessin, Delaware by EPA in September 2016 and April 2017, as well as groundwater samples

collected by EPA in April 2017 from monitoring wells located at Sunrise Cleaners and Hockessin Cleaners, show the presence of PCE and its breakdown products TCE and cis-1,2-DCE at concentrations that meet the criteria for an observed release [Refs. 1, Section 2.3; 29, pp. 8, 9, 12-15, 36-41, 110, 111, 132, 145, 157, 188, 189, 198, 211, 221, and 234; 30, pp. 5-8, 77, 90, 100, and 113; 37, pp. 1-4; 38, pp. 200-201; 47, pp. 22, 224, and 225; 48, pp. 5, 7, 46, 47, 56 and 57; 49, pp. 9-12, 14, 16, 18, 20, 21, 241, 242, 256, 268, 283, 296, 297, 309, 329, 341, 356, 368, 383, 395, 410, 423, and 440; 50, pp. 1-4].

Background Samples

As presented in **Section 3.0.1** of this HRS documentation record, shallow groundwater flows from topographically higher areas towards streams in topographically lower areas, essentially towards Mill Creek, which flows from the northwest towards the southeast[Refs. 4; 10, p. 18; 33, pp. 39 and 41]. Shallow groundwater flow direction may also be impacted by groundwater withdrawals that have greatly lowered water table levels in the regolith and Cockeysville aquifer [Ref. 33, p. 39]. Shallow groundwater at the site has been measured to flow in a northwesterly direction [Refs. 13, pp. 17 and 18; 20, pp. 15, 16, and 17]. As groundwater flows through fractures and solution openings in the deeper part of the aquifer, groundwater flow direction is affected by the orientation of the fractures and solution openings. Additionally, due to the long-term groundwater withdrawal from the aquifer, groundwater flow in the deeper part of the aquifer is towards groundwater pumping centers, including the Hockessin public supply wells [Ref. 33, pp. 39 and 41].

Tables 5 and 6 provide the hazardous substances concentrations and additional sample information for the groundwater samples used to establish background levels upgradient of each source as well as for the commingled release. Monitoring well SMW-2 is located upgradient of Source 1 (Sunrise Cleaners); therefore, sample HOC-SMW-02 is used to establish background levels for an observed release at Sunrise Cleaners. Monitoring well HMW-1 is located downgradient of Source 1 (Sunrise Cleaners) and upgradient of Source 2 (Hockessin Cleaners) (**Figure 5**); therefore, to account for contaminant migration from Sunrise Cleaners, sample HOC-HMW-01 is used to establish background levels for an observed release at Hockessin Cleaners. The background level for the commingled release is demonstrated by the same sample used for the Sunrise Cleaners facility (HOC-SMW-02), as well as additional nearby samples (HOC-P2, HOC-OB8, and HOC-DGS-1) that show contamination is not ubiquitous.

Contaminated Samples

Releases are documented at each facility individually as well as for the combined site that consists of commingled contamination from both facilities.

Tables 7 and 8 provide the hazardous substances concentrations and additional sample information for the contaminated groundwater samples used to establish observed releases for each source as well as for the commingled release. The extent of the groundwater plume depicted on **Figure 5** is based on analytical data for the groundwater samples collected in September 2016 and April 2017 from public supply wells, observation wells, and monitoring wells that meet the criteria for an observed released (**Section 3.1.1** of this HRS documentation record). The 2016 analytical results confirmed the presence of VOCs, particularly PCE and its breakdown products TCE and cis-1,2-DCE, at observed release concentrations in three of the public supply wells (P4, PG1, and PG3) and in one of the observation wells (OB10) [Refs. 1, Section 2.3; Refs. 29, pp.12-15, 38-41, 132, 133, 145, 157, 198, 199, 211, 221, 222, and 234; 30, pp. 5-8, 77, 78, 90, 100, 101, and 113; 37, pp. 1-4; 38, pp. 200-201]. The 2017 analytical data confirmed the presence of VOCs, particularly PCE and its breakdown products TCE and cis-1,2-DCE, at observed release concentrations in five of the public supply wells (P1, P3, P4, PG1, and PG3), in one observation well (OB10), in the three Hockessin Cleaners monitoring wells (HMW1, HMW2, and HMW3), and in four of the Sunrise Cleaners monitoring wells (SMW-1, SMW-3, SMW-5, and SMW-6) [Refs. 1, Section 2.3; 47, pp. 21, 24, 26, 214, 237, and 642; 48, pp. 15 and 328; 49, pp. 5, 6, 9-11, 14, 15, 17, 19, 20, 216, 229, 241, 242, 256, 268, 269, 283, 309, 310, 329, 341, 342, 356, 368, 369, 383, 410, 423, 424, 439 and 440; 50, pp. 1-4]. Analytical results for samples collected from domestic and irrigation wells also show detections of site-related contaminants in groundwater; however, an observed release was not evaluated for the domestic and irrigation wells as part of this HRS documentation record.

Release at the Sunrise Cleaners facility

The following samples qualify as release samples for the Sunrise Cleaners facility based on the criteria in the HRS: As the background levels for the Sunrise Cleaners facility are assigned at non-detect based on sample HOC-SMW-02, an observed release is established when a sample measurement exceeds the sample quantitation limit [Ref. 1, Section 2.3, Table 2-3; 49, pp. 12, 296, and 297; 50, pp. 1 and 4]. Release wells MW-01 (HOC-SMW-01), MW-03 (HOC-SMW-03), MW-05 (HOC-SMW-05), MW-06 (HOC-SMW-06 and duplicate HOC-SMW-06D), and Hockessin Cleaners well MW-01 (HOC-HMW-01), which are located within or downgradient of the Sunrise Cleaners soil source, contain PCE, TCE, and cis-1,2-DCE at levels exceeding the sample quantitation limits, thereby meeting the criteria for an observed release [Refs. 49, pp. 11, 14, 15, 17, 256, 268, 283, 309, 329, 341, 356, 368, and 383; 50, pp. 1 and 4]. The well locations of these release samples are presented on **Figure 5** [Ref. 56].

Release at the Hockessin Cleaners facility

The following samples qualify as release samples for the Hockessin Cleaners facility based on the criteria in the HRS: As the background levels for the Hockessin Cleaners facility based on sample HOC-HMW-01 (to account for contaminant migration from Sunrise Cleaners) are assigned at 140 µg/L for PCE, at 5.9 µg/L for TCE, and at non-detect for cis-1,2-DCE, an observed release is established when a sample measurement exceeds 420 µg/L for PCE, 17.7 µg/L for TCE, or the sample quantitation limit for cis-1,2-DCE [Refs. 1, Section 2.3, Table 2-3; 49, pp. 9, 241, and 242; 50, pp. 1 and 4]. Sample wells MW-02 (HOC-HMW-02) and MW-03 (HOC-HMW-03), which are located within or downgradient of the Hockessin Cleaners soil source and downgradient of background wells, contain PCE, TCE, and cis-1,2-DCE at levels that meet the criteria for an observed release [Refs. 1, Section 2.3, Table 2-3; 49, pp. 19, 20, 395, 410, 423, and 440]. The well locations of these release samples are presented on **Figure 5** [Ref. 56].

Commingled Release for the combined site

Due to the long-term groundwater withdrawal from the aquifer, groundwater flow is towards groundwater pumping centers, including the Hockessin public supply wells [Ref. 33, pp. 39 and 41]. In addition, the State of Delaware has designated the entire Cockeysville Formation outcrop area as a Wellhead Protection Area; both contaminated soil sources at the site lie completely within or above this designated Wellhead Protection Area [**Figure 2**; Ref. 46]. Based on these considerations, contamination can migrate from both sources to the Hockessin public supply wells, and to observation well OB10 located between the sources and the public supply wells. The following samples qualify as observed release samples supporting the commingled release: As the background levels for the commingled release are non-detect based on samples HOC-SMW-02, HOC-P2, HOC-OB8, and HOC-DGS-01, an observed release for a similar sample (see Sample Similarity, below) is established when a sample measurement exceeds the sample quantitation limit and the background sample quantitation limit [Refs. 1, Section 2.3, Table 2-3; 29, pp. 8, 9, 36, 37, 110, 111, 188, and 189; 37, pp. 1-2; 47, pp. 22, 224, and 225; 48, pp. 5, 7, 46, 47, 56, and 57; 49, pp. 12, 296, and 297; 50, pp. 1-4]. Release wells P1 (HOC-P1), P3 (HOC-P3), P4 (HOC-P4), PG1 (HOC-PG1), PG3 (HOC-PG3), and OB10 (HOC-OB10) contain PCE, TCE, and cis-1,2-DCE at levels exceeding the sample quantitation limits [Refs. 27, pp. 19, 20, 21, 32, 33, 37, 38, 39, 40, and 41; 28, p. 1; 29, pp. 12, 13, 14, 15, 38, 39, 40, 41, 132, 145, 157, 198, 211, 221, and 234; 30, pp. 5, 6, 7, 8, 77, 90, 100, and 113; 37, pp. 1, 2, and 4; 47, pp. 21, 24, 26, 48, 214, 237, and 642; 48, pp. 15, 25, and 328; 49, pp. 5, 6, 34, 216, and 229; 50, pp. 1, 2, 3, and 4; 51, pp. 3, 4, 19, 20, 23, 24, and 27]. The well locations of these release samples are presented on **Figure 5** [Ref. 56].

Sample Similarity

The groundwater samples used to document background levels and observed releases were collected during the same timeframe in September 2016 and April 2017 and were analyzed by a Contract Laboratory Program (CLP) laboratory through the CLP [Refs. 27, pp. 17-21, 30-33, 35-41; 28, p.1; 29, pp. 1-5; 30, pp. 1-4; 31, pp. 1-4; 47, pp. 1-4; 48, pp. 1-3; 49, pp. 1-4]. The laboratory analyzed the samples for Target Compound List (TCL) trace concentration VOCs (public supply and observation wells) or low-level VOCs (monitoring wells) according to CLP Statement of Work (SOW) SOM02.3 for the 2016 samples and SOM02.4 for the 2017 samples [Refs. 29, p. 2; 30, p. 2; 31, p. 2; 47, p. 2; 48, p. 2; 49, p. 2]. The background and release samples were collected from the same aquifer from wells of similar depth and construction for the observation and public supply wells and wells of similar depth and construction for the monitoring wells [Refs. 13, pp. 22, 28, 29, 30, 32, and 33; 20, pp. 10-17; 36, pp. 1-8; 51, pp. 2, 3, and 4]. With the exception of the sample collected from PG3 in September 2016, all samples collected from

the public supply wells in 2016 and 2107 were collected in the same manner (i.e., from a dedicated sample port following a 10- to 15-minute purge) [Refs. 27, p. 3; 51, pp. 19-24]. In September 2016, PG3 was inactive due to PCE contamination; therefore, three well volumes were purged from PG3 prior to sample collection from a dedicated sample port [Ref. 27, pp. 3 and 21]. The samples collected from the observation wells and the monitoring wells were sampled in the same manner (i.e., sample collection following purge of three well volumes) with the exception of the sample collected from Hockessin Cleaners MW-02, which was collected following recharge of well after pumping dry [Refs. 27, pp. 2-3, 17-21, 30-33, and 37-40; 51, pp. 4, 10-18, 25-27]. Additionally, with the exception of the DGS observation well, all the public supply wells and observation wells are open bedrock wells completed in the Cockeysville Formation [Ref. 36, pp. 2-8]. The DGS well is a shallow observation well completed and screened in the weathered bedrock as are the monitoring wells at the Sunrise Cleaners and Hockessin Cleaners [Refs. 13, pp. 22, 28-33; 20, pp. 9-17; 54, pp. 2-6].

Table 5

Background Wells

Sample ID	Completed Well Depth (feet bgs)	Open Hole/ Screened Interval* (feet bgs)	Aquifer	Reference(s)
Background Well, Sunrise Cleaners				
HOC-SMW-02	34.5	14 to 34*	Cockeysville	13, pp. 22 and 29
Background Well, Hockessin Cleaners**				
HOC-HMW-01	34.22	24 to 34*	Cockeysville	20, pp. 9, 12, and 15
Background Wells, Commingled Plume				
HOC-P2	332	65 to 332	Cockeysville	36, p. 2
HOC-OB8	287	82 to 287	Cockeysville	36, p. 2
HOC-DGS-01	70	45 to 59.6*	Cockeysville	54, pp. 3, 4, 5
HOC-SMW-02	34.5	14 to 34*	Cockeysville	13, pp. 22 and 29

* Indicates screened interval; well is not an open hole

** Monitoring well HMW-1 is located downgradient of Source 1 (Sunrise Cleaners) and upgradient of Source 2 (Hockessin Cleaners) (**Figure 5**); therefore, to account for contaminant migration from Sunrise Cleaners, sample HOC-HMW-01 is used to establish background levels for the observed release at Hockessin Cleaners.

bgs – below ground surface

ID - Identifier

Table 6

Background Concentrations

CLP Sample ID	Sample ID	Sample Date	Hazardous Substance	Concentration (µg/L)	Adjusted CRQL (µg/L)	Reference(s)
Background Levels, Sunrise Cleaners						
C0AR0	HOC-SMW-02	04/27/17	PCE	5U	5	49, pp. 1-4, 12, 34, and 297; 50, pp. 1 and 4; 51, p. 22
			TCE	5U	5	49, pp. 1-4, 12, 34, and 296; 50, pp. 1 and 4; 51, p. 22
			Cis-1,2-DCE	5U	5	49, pp. 1-4, 12, 34, and 296; 50, pp. 1 and 4; 51, p. 22
Background Levels, Hockessin Cleaners						
C0AQ7	HOC-HMW-01	04/25/17	PCE	140	5	49, pp. 1-4, 9, 34, and 242; 50, pp. 1 and 4; 51, pp. 3 and 10
			TCE	5.9	5	49, pp. 1-4, 9, 34, and 241; 50, pp. 1 and 4; 51, pp. 3 and 10
			Cis-1,2-DCE	5U	5	49, pp. 1-4, 9, 34, and 241; 50, pp. 1 and 4; 51, pp. 3 and 10
Background Levels, Commingled Plume						
C0AA1	HOC-P2	09/21/16	PCE	0.5U	0.5	27, p. 46; 28, p. 1; 29, pp. 1-5, 8, 9 and 111; 37, pp. 1-2
			TCE	0.5U	0.5	27, p. 46; 28, p. 1; 29, pp. 1-5, 8 and 110; 37, pp. 1-2
			Cis-1,2-DCE	0.5U	0.5	27, p. 46; 28, p. 1; 29, pp. 1-5, 8 and 110; 37, pp. 1-2
C0AN6	HOC-P2	04/26/17	PCE	0.11J	0.5	47, pp. 1-4, 22, 48, and 225; 50, pp. 1-2; 51, pp. 3 and 22

Table 6 (continued)

Background Concentrations

CLP Sample ID	Sample ID	Sample Date	Hazardous Substance	Concentration (µg/L)	Adjusted CRQL (µg/L)	Reference(s)
Background Levels, Commingled Plume (continued)						
			TCE	0.5U	0.5	47, pp. 1-4, 22, 48, and 224; 50, pp. 1-2; 51, pp. 3 and 22
			Cis-1,2-DCE	0.5U	0.5	47, pp. 1-4, 22, 48, and 224; 50, pp. 1-2; 51, pp. 3 and 22
C0AB7	HOC-OB8	09/21/16	PCE	0.5U	0.5	27, pp. 32, 33, and 41; 28, p. 1; 29, pp. 1-5, 36, 37 and 189; 37, pp. 1-2
			TCE	0.5U	0.5	27, pp. 32, 33, and 41; 28, p. 1; 29, pp. 1-5, 36 and 188; 37, pp. 1-2
			Cis-1,2-DCE	0.5U	0.5	27, pp. 32, 33, and 41; 28, p. 1; 29, pp. 1-5, 36 and 188; 37, pp. 1-2
C0AN3	HOC-OB8	04/27/17	PCE	0.5U	0.5	48, pp. 1-3, 5, 25, and 47; 50, pp. 1 and 3; 51, pp. 4 and 26
			TCE	0.5U	0.5	48, pp. 1-3, 5, 25, and 46; 50, pp. 1 and 3; 51, pp. 4 and 26
			Cis-1,2-DCE	0.5U	0.5	48, pp. 1-3, 5, 25, and 46; 50, pp. 1 and 3; 51, pp. 4 and 26
C0AQ6	HOC-DGS-01	04/27/17	PCE	0.5U	0.5	48, pp. 1-3, 7, 25, and 57; 50, pp. 1 and 3; 51, pp. 4 and 25
			TCE	0.5U	0.5	48, pp. 1-3, 7, 25, and 56; 50, pp. 1 and 3; 51, pp. 4 and 25
			Cis-1,2-DCE	0.5U	0.5	48, pp. 1-3, 7, 25, and 56; 50, pp. 1 and 3; 51, pp. 4 and 25
C0AR0	HOC-SMW-02	04/25/17	PCE	5U	5	49, pp. 1-4, 12, 34, and 297; 50, pp. 1 and 4; 51, pp. 14 and 22
			TCE	5U	5	49, pp. 1-4, 12, 34, and 296; 50, pp. 1 and 4; 51, pp. 14 and 22
			Cis-1,2-DCE	5U	5	49, pp. 1-4, 12, 34, and 296; 50, pp. 1 and 4; 51, p. 14

*The limits provided are adjusted (sample-specific) CRQLs and are equivalent to the CRQL as defined in HRS Section 1.1, Definitions [Refs. 29, pp. 2 and 4; 37, p. 1; 38, pp. 200-201; 50, p. 1].
J - estimated value – The result is ≥ the MDL and < CRQL, as such adjustment factors do not apply to these J-flagged results [Refs. 29, p. 4; 37, p. 2; 40, p. 4; 47, pp. 1-4; 50, pp. 1-2].
U - The analyte was analyzed for, but was not detected at a level greater than or equal to the level of the adjusted CRQL for sample and method [Ref. 29, p. 4].

Table 7

Contaminated Wells

Sample ID	Completed Well Depth (feet bgs)	Open Hole/Screened Interval* (feet bgs)	Aquifer	Reference(s)
Contaminated Wells, Sunrise Cleaners				
HOC-SMW-01	52	22 to 52*	Cockeysville	13, pp. 22 and 28
HOC-SMW-03	47.1	22 to 47*	Cockeysville	13, pp. 22 and 30
HOC-SMW-05	35.5	15.5 to 35.5*	Cockeysville	13, pp. 22 and 32
HOC-SMW-06	34.5	19.5 to 34.5*	Cockeysville	13, pp. 22 and 33
HOC-HMW-01	34.22	24 to 34*	Cockeysville	20, pp. 9, 12, and 15
Contaminated Wells, Hockessin Cleaners				
HOC-HMW-02	36.81	24 to 34*	Cockeysville	20, pp. 10, 13, and 16
HOC-HMW-03	42.48	25 to 40*	Cockeysville	20, pp. 11, 14, and 17
Contaminated Wells, Commingled Plume				
HOC-P1	325	32 to 325	Cockeysville	36, pp. 2 and 3
HOC-P3	312	54 to 312	Cockeysville	36, p. 2
HOC-P4	267	55 to 267	Cockeysville	36, pp. 2 and 4
HOC-PG1	199	127 to 199	Cockeysville	36, pp. 2, 5, and 6
HOC-PG3	300	82 to 305	Cockeysville	36, pp. 2, 7, and 8
HOC-OB10	298	145 to 298	Cockeysville	36, p. 2

* Indicates screened interval; well is not an open hole
bgs – below ground surface
ID - Identifier

Table 8

Contaminated Samples

CLP Sample ID	Sample ID	Sample Date	Hazardous Substance	Concentration (µg/L)	Adjusted CRQL (µg/L)	Reference(s)
Contaminated Samples, Sunrise Cleaners						
C0AQ8	HOC-SMW-01	04/25/17	PCE	5.2	5	49, pp. 1-4, 10, 34, and 256; 50, pp. 1 and 4; 51, pp. 3 and 13
C0AQ9	HOC-SMW-03	04/25/17	PCE	460	25	49, pp. 1-4, 11, 34, and 283; 50, pp. 1 and 4; 51, pp. 3 and 15
			Cis-1,2-DCE	8.6J-	5	49, pp. 1-4, 11, 34, and 268; 50, pp. 1 and 4; 51, pp. 3 and 15
C0AR2	HOC-SMW-05	04/25/17	PCE	11,000	500	49, pp. 1-4, 14, 35, and 329; 50, pp. 1 and 4; 51, pp. 3 and 16
			TCE	72	5	49, pp. 1-4, 14, 35, and 309; 50, pp. 1 and 4; 51, pp. 3 and 16
			Cis-1,2-DCE	140	5	49, pp. 1-4, 14, 35, and 309; 50, pp. 1 and 4; 51, pp. 3 and 16

Table 8 (continued)

Contaminated Samples

CLP Sample ID	Sample ID	Sample Date	Hazardous Substance	Concentration (µg/L)	Adjusted CRQL (µg/L)	Reference(s)
Contaminated Samples, Sunrise Cleaners (continued)						
C0AR4 (Duplicate of C0AR5)	HOC-SMW-06	04/25/17	PCE	1,700	200	49, pp. 1-4, 16, 35, and 356; 50, pp. 1 and 4; 51, pp. 3 and 17
			TCE	23	5	49, pp. 1-4, 16, 35, and 341; 50, pp. 1 and 4; 51, pp. 3 and 17
			Cis-1,2-DCE	110	5	49, pp. 1-4, 16, 35, and 341; 50, pp. 1 and 4; 51, pp. 3 and 17
C0AR5 (Duplicate of C0AR4)	HOC-SMW-06D	04/25/17	PCE	1,900	200	49, pp. 1-4, 18, 35, and 383; 50, pp. 1 and 4; 51, pp. 3 and 17
			TCE	25	5	49, pp. 1-4, 18, 35, and 368; 50, pp. 1 and 4; 51, pp. 3 and 17
			Cis-1,2-DCE	120	5	49, pp. 1-4, 18, 35, and 368; 50, pp. 1 and 4; 51, pp. 3 and 17
C0AQ7	HOC-HMW-01	04/25/17 04/25/17	PCE	140	5	49, pp.1-4, 9, 34, and 242; 50, pp. 1 and 4; 51, pp. 3 and 10
			TCE	5.9	5	49, pp. 1-4, 9, 34, and 241; 50, pp. 1 and 4; 51, pp. 3 and 10
Contaminated Samples, Hockessin Cleaners						
C0AR9	HOC-HMW-02	04/25/17	PCE	3,900	250	49, pp. 1-4, 20, 35, and 440; 50, pp. 1 and 4; 51, pp. 3 and 11
			TCE	550	250	49, pp. 20, 35, and 423; 50, pp. 1 and 4; 51, pp. 3 and 11
			Cis-1,2-DCE	670J-	250	49, pp. 1-4, 20, 35, and 423; 50, pp. 1 and 4; 51, pp. 3 and 11
C0AR8	HOC-HMW-03	04/25/17	TCE	140	5	49, pp. 1-4, 19, 35, and 395; 50, pp. 1 and 4; 51, pp. 3 and 12
			Cis-1,2-DCE	170	5	49, pp. 1-4, 19, 35, and 395; 50, pp. 1 and 4; 51, pp. 3 and 12
Contaminated Samples, Commingled Plume						
C0AR8	HOC-HMW-03	04/25/17	PCE	400	25	49, pp. 1-4, 21, 35, and 410; 50, pp. 1 and 4; 51, pp. 3 and 12
C0AN5	HOC-P1	04/26/17	PCE	0.58	0.5	47, pp. 1-4, 21, 48, and 214; 50, pp. 1 and 2

Table 8 (continued)

Contaminated Samples

CLP Sample ID	Sample ID	Sample Date	Hazardous Substance	Concentration (µg/L)	Adjusted CRQL (µg/L)	Reference(s)
Contaminated Samples, Commingled Plume (continued)						
C0AN7	HOC-P3	04/26/17	PCE	1.1	0.5	47, pp. 1-4, 24, 48, and 237; 50, pp. 1 and 2; 51, pp. 3 and 23
C0AA3	HOC-P4	09/19/16	PCE	16	2	27, pp. 19, 37, and 39; 28, p. 1; 29, pp. 1-5, 12, 13 and 145; 37, pp. 1 and 2
			TCE	1.1	0.5	27, pp. 19, 37, and 39; 28, p. 1; 29, pp. 1-5, 12 and 132; 37, pp. 1 and 2
			Cis-1,2-DCE	0.68	0.5	27, pp. 19, 37, and 39; 28, p. 1; 29, pp. 1-5, 12 and 132; 37, pp. 1 and 2
C0AN8	HOC-P4	04/26/17	PCE	36	5	47, pp. 1-4, 26, 48, and 642; 50, pp. 1 and 2; 51, pp. 3 and 24
C0AA4	HOC-PG1	09/19/16	PCE	14	0.50	27, pp. 20, 37, and 39; 28, p. 1; 29, pp. 1-5, 14, 15 and 157; 37, pp. 1 and 2
C0AN9	HOC-PG1	04/26/17	PCE	10	5	49, pp. 1-4, 5, 34, and 216; 50, pp. 1 and 4; 51, pp. 3 and 20
C0AA5 (duplicate of C0AA6)	HOC-PG3	09/19/16	PCE	99	10	27, pp. 21, 37, 38, and 39; 28, p. 1; 30, pp. 1-4, 5, 6 and 90; 37, pp. 1 and 4
			TCE	0.56	0.5	27, pp. 21, 37, 38, and 39; 28, p. 1; 30, pp. 1-4, 5 and 77; 37, pp. 1 and 4
			Cis-1,2-DCE	0.67	0.5	27, pp. 21, 37, 38, and 39; 28, p. 1; 30, pp. 1-4, 5 and 77; 37, pp. 1 and 4
C0AA6 (duplicate of C0AA5)	HOC-PG3	09/19/16	PCE	110	10	27, pp. 21, 37, 38, and 39; 28, p. 1; 30, pp. 1-4, 7, 8 and 113; 37, pp. 1 and 4
			TCE	0.59	0.5	27, pp. 21, 37, 38, and 39; 28, p. 1; 30, pp. 1-4, 7 and 100; 37, pp. 1 and 4
			Cis-1,2-DCE	0.7	0.5	27, pp. 21, 37, 38, and 39; 28, p. 1; 30, pp. 1-4, 7 and 100; 37, pp. 1 and 4
C0AP0	HOC-PG3	04/26/17	PCE	160	0.5	49, pp. 1-4, 6, 34, and 229; 50, pp. 1 and 2; 51, pp. 3 and 19
C0AB8 (duplicate of C0AB9)	HOC-OB10	09/20/16	PCE	320	20	27, pp. 32, 33, 40, and 41; 28, p. 1; 29, pp. 1-5, 38, 39 and 211; 37, pp. 1 and 2
			TCE	1.1	0.5	27, pp. 32, 33, 40, and 41; 28, p. 1; 29, pp. 1-5, 38 and 198; 37, pp. 1 and 2

Table 8 (continued)

Contaminated Samples

CLP Sample ID	Sample ID	Sample Date	Hazardous Substance	Concentration (µg/L)	Adjusted CRQL (µg/L)	Reference(s)
Contaminated Samples, Commingled Plume (continued)						
C0AB9 (duplicate of C0AB8)	HOC-OB10	09/20/16	PCE	390	20	27, pp. 32, 33, 40, and 41; 28, p. 1; 29, pp. 1-5, 40, 41 and 234; 37, pp. 1 and 2
			TCE	1.1	0.5	27, pp. 32, 33, 40, and 41; 28, p. 1; 29, pp. 1-5, 40, and 221; 37, pp. 1 and 2
C0AT0	HOC-OB10	04/27/17	PCE	250	20	48, pp. 1-3, 15, 25, and 328; 50, pp. 1 and 3; 51, pp. 4 and 27

*The limits provided are adjusted (sample-specific) CRQLs and are equivalent to the CRQL as defined in HRS Section 1.1, Definitions [Refs. 29, pp. 2 and 4; 37, pp. 1; 38, pp. 200-201; 50, p. 11].
J- This result is an estimated quantity, but the result may be biased low [Refs. 40, pp. 6 and 8; 49, pp. 3, 4, 11, and 20; 50, p. 4].

Additional Supporting Data

In addition to the groundwater samples collected from public supply, observation, and monitoring wells in September 2016 and April 2017, groundwater samples collected from three domestic wells (DW-1, DW-2, DW-3) and an irrigation well (IRW-1) in September 2016 also support a release at the site and continuous contamination throughout the aquifer [Refs. 27, pp. 45 and 46; 28, pp. 2 and 3; 30, pp. 9-14, 124, 151, and 162; 31, pp. 5, 6, and 73; 47, pp. 5, 8, 14, 20, 84, 120, and 169; 51, pp. 2, 5-9; 53, p. 4].

- DW-1
  - 2016 – PCE: 13 µg/L
  - 2017 – PCE: 12 µg/L

- DW-2
  - 2016 – PCE: 20 µg/L
  - 2017 – PCE: 16 µg/L

- DW-3
  - 2016 – PCE: 4.5 µg/L
  - 2017 – PCE: 50 µg/L
  - 2017 – PCE: 13 µg/L

- IRW-1
  - 2016 – PCE: 49 µg/L
  - 2017 – PCE: 34J- µg/L

Attribution:

Attribution to the Sunrise Cleaners facility:

As presented above in **Section 3.1.1** of this HRS documentation record, a background sample (HOC-SMW-02) that was collected immediately upgradient of the Sunrise Cleaners facility contained non-detected concentrations of PCE, TCE, and is-1,2-DCE. Samples collected from wells that are located immediately within or downgradient of the documented contaminated soil at Sunrise Cleaners (See **Section 2.2** of this HRS documentation record) contain concentrations of PCE, TCE, and cis-1,2-DCE that meet the criteria for an observed release. Additionally, as further presented in **Section 3.1.1**, the documented contaminated soil at the Sunrise Cleaners facility is in direct contact with shallow groundwater. Therefore, at least some portion of the contamination identified in groundwater samples HOC-SMW-01, HOC-SMW-03, HOC- SMW-5, and HOC-SMW-06, is attributable to the release of contamination from the source identified at the Sunrise Cleaners facility.

Attribution to the Hockessin Cleaners facility:

As presented above in **Section 3.1.1** of this HRS documentation record, a background sample (HOC-HMW-01) was collected from a location that is downgradient of the Sunrise Cleaners facility but immediately upgradient of the documented contaminated soil at Hockessin Cleaners (See **Section 2.2** of this HRS documentation record) facility (between the facilities). Samples collected from wells that are located immediately within or downgradient of the documented contaminated soil at Hockessin Cleaners (See **Section 2.2** of this HRS documentation record) contain concentrations of PCE, TCE, and Cis-1,2-DCE that meet the criteria for an observed release. Additionally, as further presented in **Section 3.1.1**, the documented contaminated soil at the Hockessin Cleaners facility is in direct contact with shallow groundwater. Therefore, at least some portion of the contamination identified in groundwater samples HOC-HMW-02 and HOC-HMW-03 is attributable to the release of contamination from the source identified at the Hockessin Cleaners facility.

General attribution for the combined site:

The Hockessin Groundwater site is a contaminated groundwater plume originating from at least two sources where hazardous substances have been released and infiltrated through the ground to the aquifer. As presented in **Section 3.0.1** of this HRS documentation record, shallow groundwater flows from topographically higher areas towards streams in topographically lower areas, essentially towards Mill Creek from the source areas, which flows from the northwest towards the southeast bisecting the site [Refs. 4; 33, pp. 39 and 41]. Shallow groundwater flow direction may also be impacted by groundwater withdrawals that have greatly lowered water table levels in the regolith and Cockeysville aquifer [Ref. 33, p. 39]. Shallow groundwater at the site has been measured to flow in a northwesterly direction [Refs. 4; 13, pp. 17 and 18; 20, pp. 15, 16, and 17]. As groundwater flows through fractures and solution openings in the deeper part of the aquifer, groundwater flow directions are affected by the orientation of the fractures and solution openings. Additionally, due to the long-term groundwater withdrawal from the aquifer, groundwater flow in the deeper aquifer is towards groundwater pumping centers, including the Hockessin public supply wells [Ref. 33, pp. 39 and 41]. The entirety of the Cockeysville Formation outcrop area is a designated wellhead protection area; the contaminated soil sources at the site, the public supply wells, and observation well OB10 lie entirely within this wellhead protection area [**Figure 2**; Ref. 46]. Based on these considerations, contamination can migrate from both contaminated soil sources to the Hockessin public supply wells, and to observation well OB10 located between the sources and the public supply wells.

As presented in **Section 2.2** of this HRS documentation record, two dry-cleaning facilities in Hockessin, Delaware, have documented soil contaminated with PCE and its breakdown products (TCE and cis-1,2-DCE). PCE is a man-made compound commonly used in commercial/industrial operations such as dry cleaning, metal degreasing, and manufacturing of other chemicals; it is also used in some consumer products [Ref. 21, p. 1]. PCE breaks down into TCE, cis-1,2-DCE, and vinyl chloride in the environment [Ref. 8, pp. 2 and 3].

In August 1988, the Delaware Department of Natural Resources and Environmental Control (DNREC) conducted an inspection of a dry-cleaning facility (Sunrise Cleaners) located in a commercial shopping center (Shoppes of Hockessin) at 7288 Lancaster Pike in Hockessin, Delaware [Ref. 5, p. 1]. DNREC issued a Notice of Violation to Sunrise Cleaners in November 1988 for the disposal of hazardous waste in an unlawful manner, namely disposal of

material into a dumpster [Ref. 5, p. 1]. In 1989, a preliminary environmental assessment was conducted of the shopping center in which Sunrise Cleaners is located by the property owner [Ref. 6, p. 1]. As part of the assessment, the owner of Sunrise Cleaners was interviewed and stated that approximately 200 gallons of PCE per year is used as a cleaning solvent [Ref. 6, p. 3]. The owner also indicated that no PCE waste is generated, either as non-useable fluid or machine still bottoms, and that all reported PCE loss is as a result of evaporation [Ref. 6, p. 3]. Diatomaceous earth filters were used in the dry-cleaning process [Ref. 6, p. 3]. The spent filters were reportedly drained for 3 days into the machines, then discarded into a dumpster located outside of the building awaiting off-site disposal [Ref. 6, pp. 3 and 9].

A CERCLA Preliminary Assessment (PA) was conducted by DNREC in 2005 to investigate the possible sources of the PCE identified in the public supply wells in Hockessin, Delaware [Ref. 9 pp. 1, 2, and 5]. The PA identified four dry-cleaning facilities, three operating gas stations, one former gas station, and one automobile service center as possible sources located within a 32-acre area bound by Route 41 (Lancaster Pike) to the north, the Shoppes of Hockessin shopping center to the east, Old Lancaster Pike to the south, and Valley Road to the west [Ref. 9, pp. 2, 5-11, and 16]. Two of the identified dry-cleaning facilities are Sunrise Cleaners and Hockessin Cleaners.

In August 2012, soil samples were collected from the Shoppes of Hockessin by the property owner as part of a due diligence for refinancing [Ref. 10, p. 4]. Analytical results indicated the presence of PCE up to 30,000,000 µg/kg, with the highest concentration in a soil sample collected at 19.5 feet bgs adjacent to a dry-cleaning facility, Sunrise Cleaners [Ref. 11, pp. 11 and 13]. In May 2013, the property owners for the Shoppes of Hockessin entered into DNREC's Voluntary Cleanup Program (VCP) [Ref. 12, pp. 1-9]. In June 2013, an investigation was conducted of the soil in the vicinity of Sunrise Cleaners by the shopping center property owner [Ref. 10, pp. 1, 8, 9, 11, and 20]. Collected soil samples showed the presence of PCE at concentrations as high as 11,000 µg/kg at a depth of 19 to 19.5 feet bgs and as deep as 32 to 32.5 feet bgs at a concentration of 7,900 µg/kg [Ref. 10, p. 34]. Additionally, PCE breakdown products such as TCE (as high as 300 µg/kg) and cis-1,2-DCE (as high as 1,300 µg/kg) were detected in the soil samples ranging in depth from 2 to 32.5 feet bgs [Refs. 8, pp. 2 and 3; 10, p. 34]. In 2015, under the VCP, the property owner of the Shoppes of Hockessin, installed six monitoring wells ranging in depth from 10 to 52 feet bgs in the vicinity of Sunrise Cleaners [Ref. 13, pp. 18 and 22]. Analytical results for groundwater samples collected from the monitoring wells indicated the presence of PCE as high as 13,000 µg/L [Ref. 13, p. 24].

In 2015, DNREC conducted facility investigations at two additional dry-cleaning facilities, Hockessin Cleaners and Thompson Cleaners, in Hockessin, Delaware, in an attempt to further determine the source of PCE in the public supply wells [Refs. 14, pp. 1 and 7; 15, pp. 1 and 5]. An investigation was not conducted at the fourth dry-cleaning facility, Reynolds Dry Cleaning, identified in the PA because it was determined that this facility was a drop-off location only; no dry-cleaning activities take place on the premises [Ref. 9, p. 6]. At Hockessin Cleaners, located at 7313 Lancaster Pike, DNREC collected 10 surface soil samples and advanced four soil borings for subsurface soil sample collection [Ref. 14, pp. 9, 21, 22, and 37]. Analytical results for the collected soil samples indicated the presence of PCE as high as 1,100 µg/kg in a surface soil sample and 3,000 µg/kg at a depth of 22 to 24 feet bgs [Ref. 14, pp. 26-30]. Additionally, PCE breakdown products such as TCE (as high as 130 µg/kg-estimated) and cis-1,2-DCE (as high as 520 µg/kg) were detected in the soil samples [Refs. 8, pp. 2 and 3; 14, pp. 26-30]. Analytical results for surface and subsurface soil samples collected from Thompson Cleaners, located at 7465 Lancaster Pike, did not show the presence of PCE [Refs. 9, p. 6; 15, p. 19].

Throughout 2016, under the VCP, the property owner at Sunrise Cleaners conducted environmental investigations, including quarterly monitoring well sampling and soil gas sampling [Refs. 16, pp. 3 and 10; 17, pp. 1-3, and 6]. In April 2016, a soil vapor extraction/air sparging remediation system was installed and began operating at Sunrise Cleaners [Ref. 18, pp. 1, 3, and 6].

In April 2016, Hartnett Properties, the owners of the property on which Hockessin Cleaners is located, entered into DNREC's VCP [Ref. 19, pp. 1-9]. In August 2016, Hartnett Properties conducted a Phase II facility investigation in the vicinity of Hockessin Cleaners, which included the collection of soil and groundwater samples [Ref. 20, pp. 1 and 2]. Analytical results for soil samples documented the presence of PCE as high as 5,900 µg/kg [Ref. 20, pp. 2 and 7]. Additionally, PCE breakdown products, such as TCE (as high as 610 µg/kg) and cis-1,2-DCE (as high as 510 µg/kg), were detected in the soil samples ranging in depth from 0 to 21 feet bgs [Refs. 8, pp. 2 and 3; 20, p. 7]. Groundwater samples contained PCE at concentrations as high as 7,500 µg/L [Ref. 20, p. 8]. Groundwater samples

also contained PCE breakdown products such as TCE (as high as 1,100 µg/L), cis-1,2-DCE (as high as 1,000 µg/L), and vinyl chloride (as high as 6 µg/L) [Refs. 8, pp. 2 and 3; 20, p. 8].

The site is located in a commercial area; a search of environmental databases identified seven hazardous substances release facilities, 11 leaking underground storage tanks, one Resource Conservation and Recovery Act (RCRA) Conditionally Exempt Small Quantity Generator (CESQG), and three historical automobile service stations [Ref. 22, pp. 9-12, 15, and 16]. Two of the identified hazardous substances release facilities, Hockessin Cleaners and Sunrise Cleaners, are being evaluated as part of this HRS documentation record. Of the remaining five hazardous substances release facilities, PCE and its breakdown products are not identified as hazardous substances associate with those facilities [Ref. 22, pp. 75-79]. The 11 identified leaking underground storage tanks are primarily associated with automobile service stations; PCE and its breakdown products are not hazardous substances associated with these facilities [Ref. 22, pp. 21-26, 30-33, 36, 38-39, 57-58, 60, and 71-75].

Hazardous Substances Released:

Tetrachloroethylene (PCE)
Trichloroethylene (TCE)
Cis-1,2-Dichloroethylene (cis-1,2-DCE)

==========

Ground Water Observed Release Factor Value: 550

3.2 WASTE CHARACTERISTICS

3.2.1 Toxicity/Mobility

Hazardous Substance	Source Numbers	Toxicity Factor Value	Mobility Factor Value*	Toxicity/ Mobility	References
Tetrachloroethylene	1, 2, OR	100	1.0	100	1a, Section 2.4.1.1; 2, p. 6
Trichloroethylene	1, 2, OR	1,000	1.0	1,000	1a, Section 2.4.1.1; 2, p. 10
Cis-1,2-Dichloroethylene	1, 2, OR	1,000	1.0	1,000	1a, Section 2.4.1.1; 2, p. 1

OR = Observed Release
* – Hazardous substances meeting the criteria for an observed release by chemical analysis to an aquifer underlying a source are assigned a mobility factor value of 1 [Ref. 1, Section 3.2.1.1].

3.2.2 Hazardous Waste Quantity

Source Number	Source Hazardous Waste Quantity (HWQ) Value (Ref. 1 Section 2.4.2.1.5)	Is source hazardous constituent quantity data complete? (yes/no)
1	>0	No
2	>0	No
Sum of Values:	>0, rounded to 1 [Ref. 1, Section 2.4.2.2]	

The sum corresponds to a hazardous waste quantity factor value of 1 in Table 2-6 of the HRS [Ref. 1, Section 2.4.2.2]. However, because the hazardous constituent quantity is not adequately determined (see **Section 2.4.2.1.1** of this HRS documentation record) and targets are subject to Level I and Level II concentrations (see **Section 3.3.2.3** of this HRS documentation record), a pathway hazardous waste quantity factor value of 100 is assigned if it is greater than the hazardous waste quantity value from Table 2-6 (i.e., 1) [Ref. 1, Section 2.4.2.2]. Therefore, a hazardous waste quantity factor value of 100 is assigned for the ground water migration pathway [Ref. 1, Section 2.4.2.2].

Hazardous Waste Quantity Factor Value: 100

3.2.3 Waste Characteristics Factor Category Value

TCE and cis-1,2-DCE correspond to the toxicity/mobility factor value of 1,000, as shown previously (see **Section 3.2.1** of this HRS documentation record).

Toxicity/Mobility Factor Value (1,000) x Hazardous Waste Quantity Factor Value (100): 100,000

The product (100,000) corresponds to a Waste Characteristics Factor Category Value of 18 in Table 2-7 of the HRS [Ref. 1, Section 2.4.3.1].

==========

Hazardous Waste Quantity Factor Value: 100
Waste Characteristics Factor Category Value: 18

3.3 TARGETS

Artesian Water Company has six public supply wells in Hockessin, Delaware, that are completed in the Cockeysville aquifer [Ref. 36, pp. 2-8; Figure 6]. As presented in **Section 3.1.1**, three of the six public supply wells (PG1, PG3, and P4) have documented Level I VOC contamination attributable to the sources being evaluated. Because the Level I concentrations in those three target wells lead to a maximum HRS score of 100.00 for the ground water migration pathway, the Potential Contamination Factor Value is not scored and other drinking-water wells within the 4-mile TDL are not included in this discussion.

Artesian's water supply system consists of 51 groundwater wells, which includes 48 active and 3 emergency wells, and purchased surface water from Chester Water Authority and the City of Wilmington [Refs. 23, pp. 1-3; 26, pp. 21, 25, and 39-42; 45]. Artesian has two aquifer storage and recovery (ASR) wells that are used to store water from the system by pumping water into the aquifer then pumping it back out during dry periods [Refs. 23, pp. 2 and 3; 26, pp. 26, 27, 37, 38, and 40]. Water is pumped into and out of the Llangollen ASR well, for water supply distribution and the well is accounted for in the 48 active wells. The other ASR well, Fairwinds, is only used for pumping water into the aquifer; therefore, for this HRS documentation record, it is not counted as a water supply well [Refs. 23, p. 2 and 3; 26, pp. 26-28]. Artesian maintains interconnections with several additional adjacent water utilities for emergency purposes [Ref. 26, pp. 25, 26, and 42]. The system is a single interconnected distribution system with no one well or purchased water source providing more than 40% of the total volume of supplied water [Refs. 23, pp. 2 and 3; 26, pp. 37-42]. As of April 1, 2017, Artesian had 69,083 metered customers [Ref. 23, p. 2]. In addition to the population served by the Artesian system in Delaware, Artesian also supplies water to the Town of Elkton [Refs. 23, p. 2; 25, p. 1]. The purchased water from Artesian (7.5 million gallons) is mixed with Elkton's finished surface water (24.7 million gallons) and groundwater from two wells (1.4 and 13.1 million gallons) in a reservoir [Ref. 25, p. 2].

The target population is apportioned as follows:

For the Town of Elkton, because the surface water intake contributes more than 40% to the total volume of the system, the population is apportioned by percentage contributed to total supply [Refs. 1, Section 3.3.2; 25, pp. 1-3]:

- 7.5 million gallons (purchased water from Artesian) divided by 46.7 million gallons (total water supply of the City of Elkton) = 0.16, times 17,039 (total population served by the Town of Elkton) = 2,726.24 persons [Ref. 25, pp. 1-3].

For Artesian, because no one well or purchased water source contributes more than 40% of the total water supply, the target population is apportioned evenly among the 53 water sources (51 wells and 2 purchased water sources) [Refs. 1, Section 3.3.2; 23, p. 3; 26, pp. 37-42]:

- 69,083 metered customers multiplied by 2.63 (persons per household in New Castle County) = 181,688.29 persons + 2726.24 (persons apportioned to purchased Artesian water in Elkton) = 184,414.53 (total persons supplied water by Artesian) divided by 53 (51 wells plus 2 purchased water sources) = 3,479.52 persons per well [Refs. 23, p. 3; 24, p. 1; 26, pp. 37-42].

The following Artesian drinking water wells are subject to Level I or Level II concentrations and each is assigned a population of 3,479.52 as calculated above.

Well	Distance from Source (mi.)*	Population	Level I Conc. (Y/N)**	Level II Conc. (Y/N)**	Potential Contam. (Y/N)	Reference(s)
PG1	0.395 – Source 1 0.475 – Source 2	3,479.52	Y	N	N	Figure 2; 23, p. 3; 24, p. 1; 25, pp. 1-3; 26, pp. 37-42; 56
PG3	0.255 – Source 1 0.312 – Source 2	3,479.52	Y	Y	N	Figure 2; 23, p. 3; 24, p. 1; 25, pp. 1-3; 26, pp. 37-42; 56
P1	0.430 – Source 1 0.455 – Source 2	3,479.52	N	Y	N	Figure 2; 23, p. 3; 24, p. 1; 25, pp. 1-3; 26, pp. 37-42; 56
P3	0.343 – Source 1 0.347 – Source 2	3,479.52	N	Y	N	Figure 2; 23, p. 3; 24, p. 1; 25, pp. 1-3; 26, pp. 37-42; 56
P4	0.216 – Source 1 0.112 – Source 2	3,479.52	Y	Y	N	Figure 2; 23, p. 3; 24, p. 1; 25, pp. 1-3; 26, pp. 37-42; 56

* Distances are measured from Source 1 and Source 2, respectively [Figure 2].

** Maximum Contaminant Level/Maximum Contaminant Level Goal (MCL/MCLG), Cancer Risk screening concentration (CRSC), and Non-Cancer Risk screening concentrations (NCRSC) were used as benchmarks to evaluate the level of contamination [Ref. 1, Section 2.5.2].

Applicable benchmarks for the contaminants detected in the observed release, presented here in µg/L for consistency with reported data, are as follows.

Substance	MCL/MCLG	CRSC	NCRSC	Reference(s)
PCE	5	37	100	2, p. 6
TCE	5	1.1	10	2, p. 10
Cis-1,2-DCE	70	NA	40	2, p. 2

Level I Concentrations

Well	Sample	Substance	Conc. (µg/L)	Benchmark (µg/L)	Reference(s)
PG1	HOC-PG1	PCE	14	5 (MCL)	2, p. 6; 29, pp. 14, 15, and 145; 37, p. 2
			10	5 (MCL)	2, p. 6; 49, pp. 5 and 216; 50, pp. 1 and 4
PG3	HOC-PG3/ HOC-PG3D	PCE	99/110	5 (MCL)	2, p. 6; 30, pp. 5, 6, 7, 8, 90, and 113; 37, p. 4
	HOC-PG3	PCE	160	5 (MCL)	2, p. 6; 49, pp. 6 and 229; 50, pp. 1 and 2
P4	HOC-P4	PCE	16	5 (MCL)	2, p. 6; 29, pp. 12, 13, and 145; 37, p. 2
		TCE	1.1	1.1 (cancer risk)	2, p. 10; 29, pp. 12 and 132; 37, p. 2
		PCE	36	5 (MCL)	2, p. 6; 47, pp. 26 and 642; 50, pp. 1 and 2

Level II Concentrations

Well	Sample	Substance	Conc. (µg/L)	Benchmark (µg/L)	Reference(s)
PG3	HOC-PG3/ HOC-PG3D	TCE	0.56/0.59	5 (MCL)	2, p. 10; 30, pp. 5, 7, 90, and 113; 37, p. 4
		Cis-1,2-DCE	0.67/0.7	40 (non-cancer risk)	2, p. 2; 30, pp. 5, 7, 90, and 113; 37, p. 4
P1	HOC-P1	PCE	0.58	5 (MCL)	2, p. 6; 47, pp. 21 and 214; 50, pp. 1 and 2
P3	HOC-P3	PCE	1.1	5 (MCL)	2, p. 6; 47, pp. 24, and 237; 50, pp. 1 and 2
P4	HOC-P4	Cis-1,2-DCE	0.68	40 (non-cancer risk)	2, p. 2; 29, p. 12 and 132; 37, p. 2

3.3.1 Nearest Well

As identified in **Section 3.3** of this HRS documentation record, Artesian supply wells PG1, PG3, and P4 are subject to Level I concentrations. Therefore, a nearest well factor value of 50 is assigned [Ref. 1, Section 3.3.1, Table 3-10].

==========

Nearest Well Factor Value: 50

3.3.2 Population

3.3.2.2 Level I Contamination

As identified in **Section 3.3** of this HRS documentation record, Artesian supply wells PG1, PG3, and P4 are subject to Level I concentrations. The populations assigned to the wells are also explained in **Section 3.3** of this HRS documentation record.

Level I Well	Population	Reference(s)
PG1	3,479.52	2, p. 6; 23, p. 3; 24, p. 1; 25, pp. 1-3; 26, pp. 37-42
PG3	3,479.52	2, p. 6; 23, p. 3; 24, p. 1; 25, pp. 1-3; 26, pp. 37-42
P4	3,479.52	2, pp. 6 and 9; 23, p. 3; 24, p. 1; 25, pp. 1-3; 26, pp. 37-42

The total population served by drinking water from points of withdrawal subject to Level I concentrations is 10,438.56 (3,479.52 * 3) [Ref. 1, Section 3.3.2]. This population is multiplied by 10 to determine the Level I concentrations factor value, as shown below [Ref. 1, Section 3.3.2.2].

==========

Total Level I Population: 10,438.56
Level I Concentration Factor Value: 10,438.56 x 10 = 104,385.6
[Ref. 1, Section 3.3.2.2]

3.3.2.3 Level II Concentrations

The populations served by the contaminated drinking water wells (PG1, PG3, and P4) are already counted under the Level I concentrations factor. As identified in **Section 3.3** of this documentation record, Artesian supply wells P1 and P3 are subject to Level II concentrations. The populations assigned to the wells are also explained in **Section 3.3** of this HRS documentation record.

Level II Well	Population	Reference(s)
P1	3,479.52	2, pp., 6; 23, p. 3; 24, p. 1; 25, pp. 1-3; 26, pp. 37-42
P3	3,479.52	2, p. 6; 23, p. 3; 24, p. 1; 25, pp. 1-3; 26, pp. 37-42

The total population served by drinking water from points of withdrawal subject to Level II concentrations is 6,959.04 (3,479.52 * 2) [Ref. 1, Sections 3.3.2 and 3.3.2.3].

==========

Total Level II Population: 6,959.04
Level II Concentration Factor Value: 6,959.04
[Ref. 1, Section 3.3.2.3]

3.3.2.4 Potential Contamination

Because Level I concentrations result in a maximum score of 100.00 for the ground water migration pathway, the Potential Contamination Factor Value was not scored.

3.3.3 Resources

Because Level I concentrations result in a maximum score of 100.00 for the ground water migration pathway, the Resources Factor Value was not scored.

==========

Resources Factor Value: Not scored

3.3.4 Wellhead Protection Area

The State of Delaware has designated the entire Cockeysville Formation as a Wellhead Protection Area in accordance with the federal Safe Drinking Water Act [**Figure 2**; Refs. 46; 57, p. 1]. Because both sources have a groundwater containment factor value greater than 0 and lie completely within or above the designated Wellhead Protection Area, and because observed groundwater contamination attributable to the sources at the site lies within the designated Wellhead Protection Area, a Wellhead Protection Area Factor Value of 20 is assigned [Ref. 1, Section 3.3.4].

==========

Wellhead Protection Area Factor Value: 20

APPENDIX A

HRS Scoring and Target Information Showing That Sunrise Cleaners Will Score Above 28.50 Independently and Qualify For The NPL

Sunrise Cleaners

GROUND WATER MIGRATION PATHWAY Factor Categories & Factors	**MAXIMUM VALUE**	**Sunrise Cleaners Value Assigned**
Likelihood of Release		
1. Observed Release	550	550 (see below)
2. Potential to Release		
2a. Containment	10	
2b. Net Precipitation	10	
2c. Depth to Aquifer	5	
2d. Travel Time	35	
2e. Potential to Release [lines 2a(2b+2c+2d)]	500	
3. Likelihood of Release	550	**550**
Waste Characteristics		
4. Toxicity/Mobility		1,000 (see below)
5. Hazardous Waste Quantity		10 (see below)
6. Waste Characteristics	100	**10**
Targets		
7. Nearest Well	50	**20** (see below)
8. Population		
8a. Level I Concentrations	**	NS
8b. Level II Concentrations	**	NS
8c. Potential Contamination	**	1,534 (see below)
8d. Population (lines 8a+8b+8c)	**	1,534
9. Resources	5	NS
10. Wellhead Protection Area	20	20 (see below)
11. Targets (lines 7+8d+9+10)	**	**1,574**
12. Aquifer Score (lines 3x6x11 divided by 82,500)	100	100.00
13. Ground Water Migration Pathway Score (S_{gw})	100	**100.00**

NS = Not scored

Source

Sunrise Cleaners contains contaminated soil, Source 1[see section 2.2 of the HRS documentation record].

Likelihood of Release

The likelihood of release assigned value is based on an observed release to the aquifer in monitoring wells at the Sunrise Cleaners facility [see section 3.1 of the HRS documentation record].

Ground Water Observed Release Factor Value: 550

Waste Characteristics

The sum of the source waste quantity corresponds to a hazardous waste quantity factor value of 1 in Table 2-6 of the HRS. However, because the hazardous constituent quantity is not adequately determined and this scoring scenario evaluates no targets subject to Level I or Level II contamination, either the value from HRS Table 2-6 or a value of 10, whichever is greater, is assigned as the hazardous waste quantity factor value for the pathway [Ref. 1, Section 2.4.2.2]. A pathway hazardous waste quantity of 10 is assigned.

Hazardous Waste Quantity Factor Value: 10

A toxicity/mobility of 1,000 is assigned based on TCE and cis-1,2-DCE [See sections 3.1 and 3.2.1 of the HRS documentation record].

Toxicity/Mobility Factor Value (1,000) x Hazardous Waste Quantity Factor Value (10): 10,000

The product (10,000) corresponds to a Waste Characteristics Factor Category Value of 10 in Table 2-7 of the HRS [Ref. 1, Section 2.4.3.1].

Waste Characteristics Factor Category Value: 10

Targets

Nearest Well: Well P4 is within a ¼ mile of Source 1. Therefore, a nearest well factor value of 20 is assigned [Refs. 1, Section 3.3.1, Table 3-10; 55, p. 5].

Nearest Well Factor Value: 20

Potential Contamination

The distance-weighted populations are assigned based on information in the HRS documentation record stating the distance of each target well from each source. The HRS documentation record provides the following information [see section 3.3 of the HRS documentation record and Ref. 55, p. 5]:

Target Well	**Distance from Source (mi.)**	**Population**
PG1	0.395 – Source 1	3,479.52
PG3	0.255 – Source 1	3,479.52
P1	0.430 – Source 1	3,479.52
P3	0.343 – Source 1	3,479.52
P4	0.216 – Source 1	3,479.52

Note: Source 1 is contaminated soil at the Sunrise Cleaners facility.

Distance Category (miles)	Target Well	Population	Table 3-12 Assigned Value
Karst			
0 to ¼	P4	3,479.52	5,214
Greater than ¼ to ½	PG1, PG3, P1, P3	13,918.08	10,122
Greater than ½ to 1			
Greater than 1 to 2			
Greater than 2 to 3			
Greater than 3 to 4			

Calculations:

Sum of Distance-Weighted Population Values: 5,214 + 10,122 = 15,336
Sum of Distance-Weighted Population Values/10: 15,336 ÷ 10 = 1,533.6, (1,533.6 is rounded to 1,534 according to HRS Section 3.3.2.4)

Sunrise Cleaners Potential Contamination Factor Value: 1,534

Resources: Not Scored

Resources Factor Value: Not Scored

Wellhead Protection Area: The State of Delaware has designated the entire Cockeysville Formation as a Wellhead Protection Area in accordance with the federal Safe Drinking Water Act [Figure 2; Refs. 46; 57, p. 1]. Because Source 1 has a groundwater containment factor value greater than 0 and lie completely within or above the designated Wellhead Protection Area, and because observed groundwater contamination attributable to the source at the site lies within the designated Wellhead Protection Area, a Wellhead Protection Area Factor Value of 20 is assigned [Ref. 1, Section 3.3.4].

Wellhead Protection Area Factor Value: 20

Sunrise Cleaners Scores:

Ground Water Pathway		100.00
Surface Water Pathway		Not Scored
Soil Exposure and Subsurface Intrusion Pathway		Not Scored
Air Pathway		Not Scored
HRS SITE SCORE	50.00	

APPENDIX B

HRS Scoring and Target Information Showing That Hockessin Cleaners Will Score Above 28.50 Independently and Qualify For The NPL

Hockessin Cleaners

GROUND WATER MIGRATION PATHWAY Factor Categories & Factors	**MAXIMUM VALUE**	**Hockessin Cleaners Value Assigned**
Likelihood of Release		
1. Observed Release	550	500 (see below)
2. Potential to Release		
2a. Containment	10	
2b. Net Precipitation	10	
2c. Depth to Aquifer	5	
2d. Travel Time	35	
2e. Potential to Release [lines 2a(2b+2c+2d)]	500	
3. Likelihood of Release	550	**550**
Waste Characteristics		
4. Toxicity/Mobility		1,000 (see below)
5. Hazardous Waste Quantity		10 (see below)
6. Waste Characteristics	100	**10**
Targets		
7. Nearest Well	50	**20** (see below)
8. Population		
8a. Level I Concentrations	**	NS
8b. Level II Concentrations	**	NS
8c. Potential Contamination	**	1,534 (see below)
8d. Population (lines 8a+8b+8c)	**	1,534
9. Resources	5	NS
10. Wellhead Protection Area	20	20 (see below)
11. Targets (lines 7+8d+9+10)	**	**1,574**
12. Aquifer Score (lines 3x6x11 divided by 82,500)	100	100.00
13. Ground Water Migration Pathway Score (S_{gw})	100	**100.00**

NS = Not scored

Source

Hockessin Cleaners contains contaminated soil, Source 2 [see section 2.2 of the HRS documentation record].

Likelihood of Release

The likelihood of release assigned value is based on an observed release to the aquifer in monitoring wells at the Hockessin Cleaners facility [see section 3.1 of the HRS documentation record].

Ground Water Observed Release Factor Value: 550

Waste Characteristics

The sum of the source waste quantity corresponds to a hazardous waste quantity factor value of 1 in Table 2-6 of the HRS. However, because the hazardous constituent quantity is not adequately determined and there are no targets subject to Level I or Level II contamination, either the value from HRS Table 2-6 or a value of 10, whichever is greater, is assigned as the hazardous waste quantity factor value for the pathway [Ref. 1, Section 2.4.2.2]. A pathway hazardous waste quantity of 10 is assigned.

Hazardous Waste Quantity Factor Value: 10

A toxicity/mobility of 1,000 is assigned based on TCE and cis-1,2-DCE [see sections 3.1 and 3.2.1 of the HRS documentation record].

Toxicity/Mobility Factor Value (1,000) x Hazardous Waste Quantity Factor Value (10): 10,000

The product (10,000) corresponds to a Waste Characteristics Factor Category Value of 10 in Table 2-7 of the HRS [Ref. 1, Section 2.4.3.1].

Waste Characteristics Factor Category Value: 10

Targets

Nearest Well: Well P4 is within a ¼ mile of Source 2. Therefore, a nearest well factor value of 20 is assigned [Refs. 1, Section 3.3.1, Table 3-10; 55, p. 6].

Nearest Well Factor Value: 20

Potential Contamination

The distance-weighted populations are assigned based on information in the HRS documentation record stating the distance of each target well from each source. The HRS documentation record provides the following information [see section 3.3 of the HRS documentation record and Ref. 55, p. 6]:

Target Well	**Distance from Source (mi.)**	**Population**
PG1	0.475 – Source 2	3,479.52
PG3	0.312 – Source 2	3,479.52
P1	0.455 – Source 2	3,479.52
P3	0.347 – Source 2	3,479.52
P4	0.112 – Source 2	3,479.52

Note: Source 2 is contaminated soil at the Hockessin Cleaners facility.

Distance Category (miles)	Target Well	Population	Table 3-12 Assigned Value
Karst			
0 to ¼	P4	3,479.52	5,214
Greater than ¼ to ½	PG1, PG3, P1, P3	13,918.08	10,122
Greater than ½ to 1			
Greater than 1 to 2			
Greater than 2 to 3			
Greater than 3 to 4			

Calculations:

Sum of Distance-Weighted Population Values: 5,214 + 10,122 = 15,336
Sum of Distance-Weighted Population Values/10: 15,336 ÷ 10 = 1,533.6 (1,533.6 is rounded to 1,534 according to HRS Section 3.3.2.4)

Hockessin Cleaners Potential Contamination Factor Value: 1,534

Resources: Not Scored

Resources Factor Value: Not Scored

Wellhead Protection Area: The State of Delaware has designated the entire Cockeysville Formation as a Wellhead Protection Area in accordance with the federal Safe Drinking Water Act [Figure 2; Refs. 46; 57, p. 1]. Because Source 2 has a groundwater containment factor value greater than 0 and lie completely within or above the designated Wellhead Protection Area, and because observed groundwater contamination attributable to the source at the site lies within the designated Wellhead Protection Area, a Wellhead Protection Area Factor Value of 20 is assigned [Ref. 1, Section 3.3.4].

Wellhead Protection Area Factor Value: 20

Hockessin Cleaners Scores:

Ground Water Pathway	100.00
Surface Water Pathway	Not Scored
Soil Exposure and Subsurface Intrusion Pathway	Not Scored
Air Pathway	Not Scored
HRS SITE SCORE	50.00